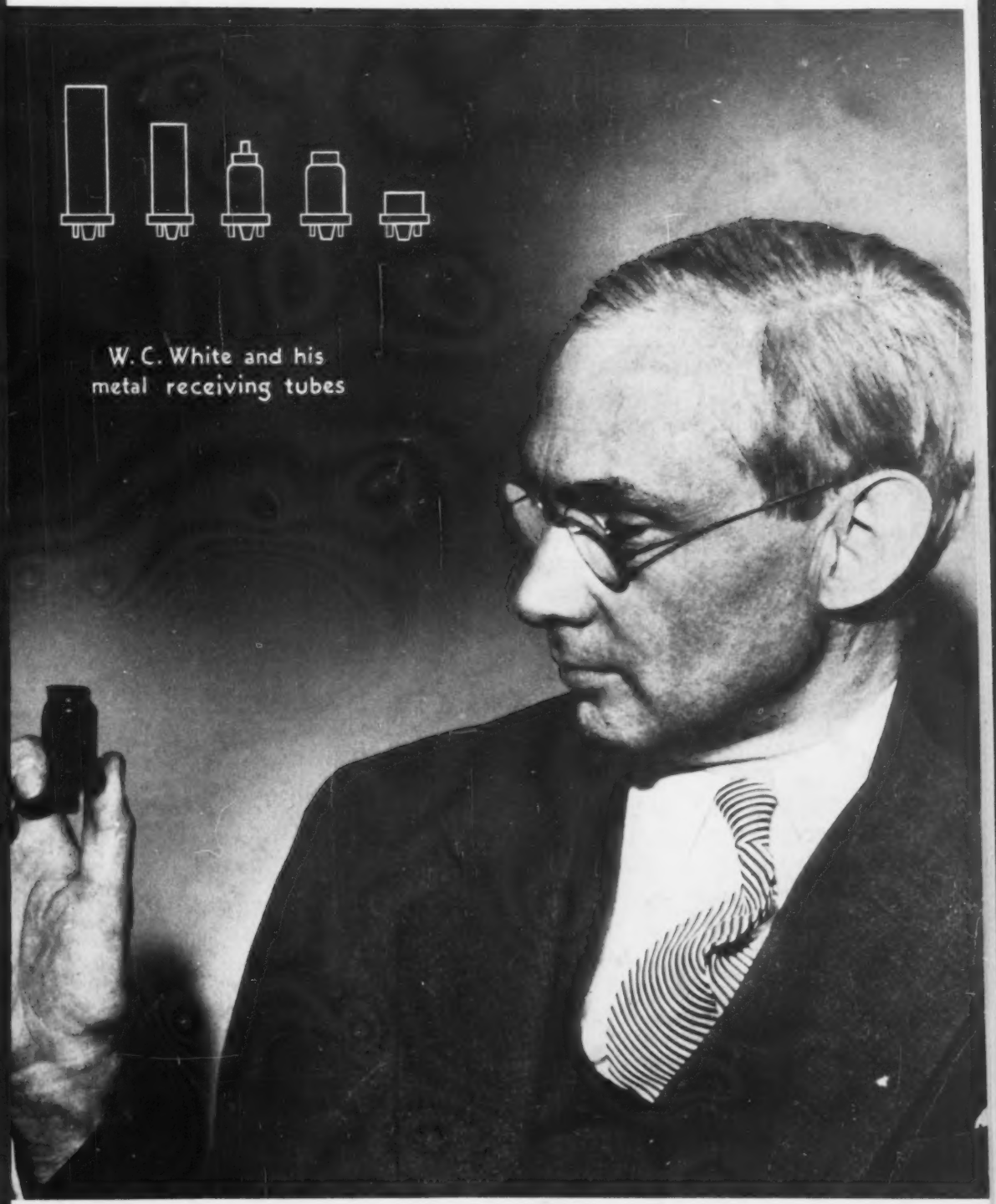
MAY 20 1935

electronics

radio, sound, communications and industrial applications of electron tubes · · · design, engineering, manufacture



W. C. White and his metal receiving tubes

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

MAY 1935

★

In the interest of well designed radios we offer suggestion

No. 2 'TAMBOUR'

THE INSPIRATION FOR this attractive radio cabinet design was the "Tambour" (roll front) desk of the master cabinet makers of the early 19th Century. In this modern conception, however, the cabinet is of lustrous jet-black Bakelite Molded formed in one press operation, instead of being fashioned with the tools of a skilled craftsman. The tambour front is of a contrasting color of Bakelite Material, and the beauty of the cabinet is accented by gleaming chromium plated knobs and pilasters.

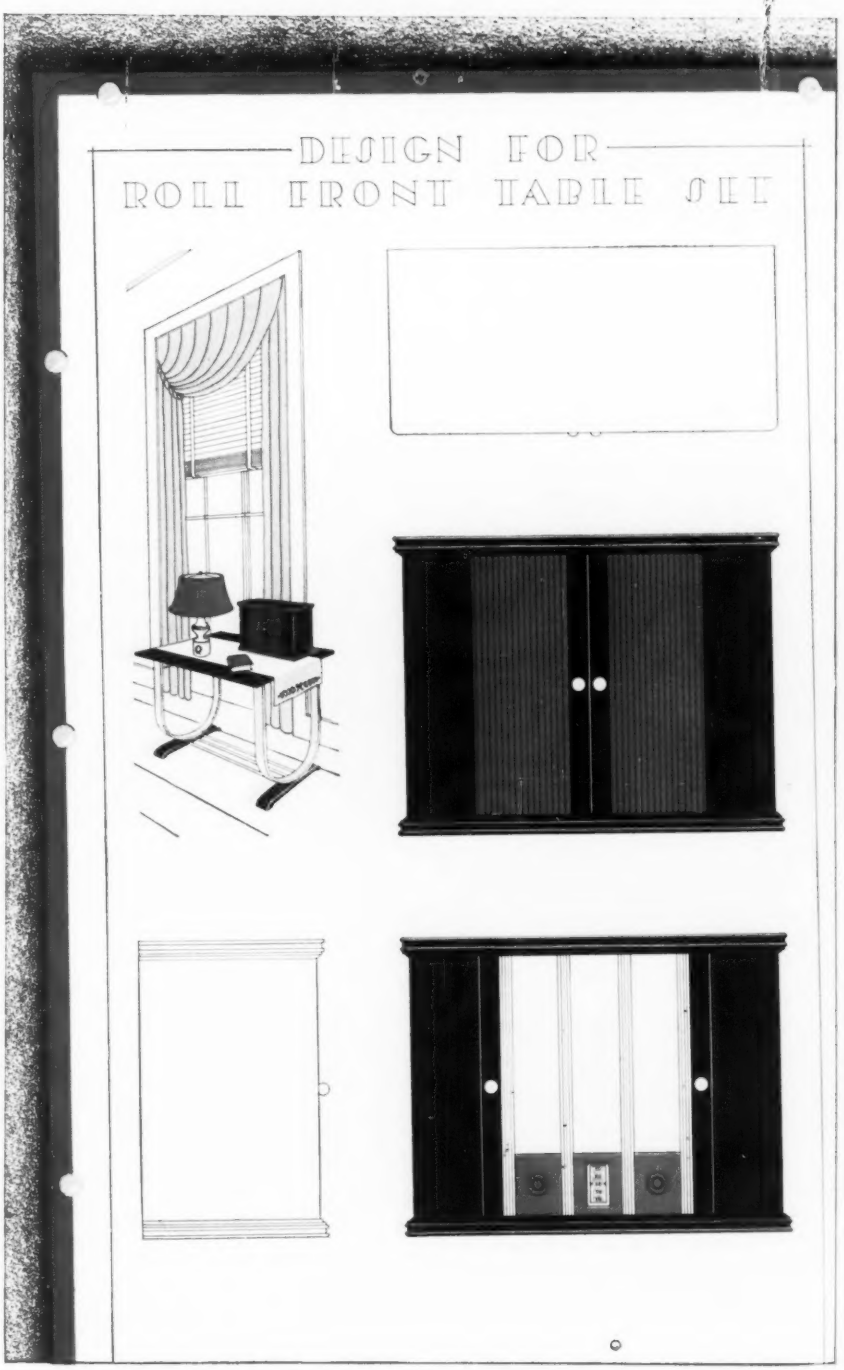
While this "Tambour" radio would merge with room furnishings of any period or type, it would be especially attractive in a room furnished and decorated in the modern manner, where the use of plastics and metal play such an important role.

The possibilities of Bakelite Molded for radio cabinets of unusual and really beautiful designs appear to be unlimited. There is the further advantage that these cabinets, when quantities are sufficiently large, may be produced most economically. We would be glad indeed to discuss these possibilities with radio manufacturers, and to cooperate with them if this is desired.

We also invite you to write for a copy of our illustrated Booklet 13M, "Bakelite Molded".

★

Design by Richmond Lane Chipman, Jr.



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THE MATERIAL OF A THOUSAND USES

ELECTRONICS, May, 1935. Vol. 8, No. 5. Published monthly, price 35c. a copy. Subscription rates—United States, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 16 shillings. Entered as second class matter, April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1935 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y.

Printed by The Schweinler Press, N. Y.

NEW YORK:
McGRAW-HILL
PUBLISHING
COMPANY, INC.

electronics

May 1935

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GRAPHIC ARTS INDUSTRY

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sound pictures
telephony
broadcasting
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therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

In this issue . . .

Who can grant tube-circuit licenses?

Most engineers and business men in the radio and electronics fields appear to be considerably puzzled about the present set-up concerning licenses under patents of the A.T.&T., G.E., R.C.A., and Westinghouse relating to electronic tubes and circuits. So on the next pages, the editors give a simplified picture of this complex situation, condensed from the voluminous legal texts of the agreements.

Metal tubes - an industry viewpoint

Everyone seems to be in a dither about the new tubes. On the following pages some questions are asked, some questions are answered, and the radio industry's thinking is outlined.

Automobile radio - 1935 model

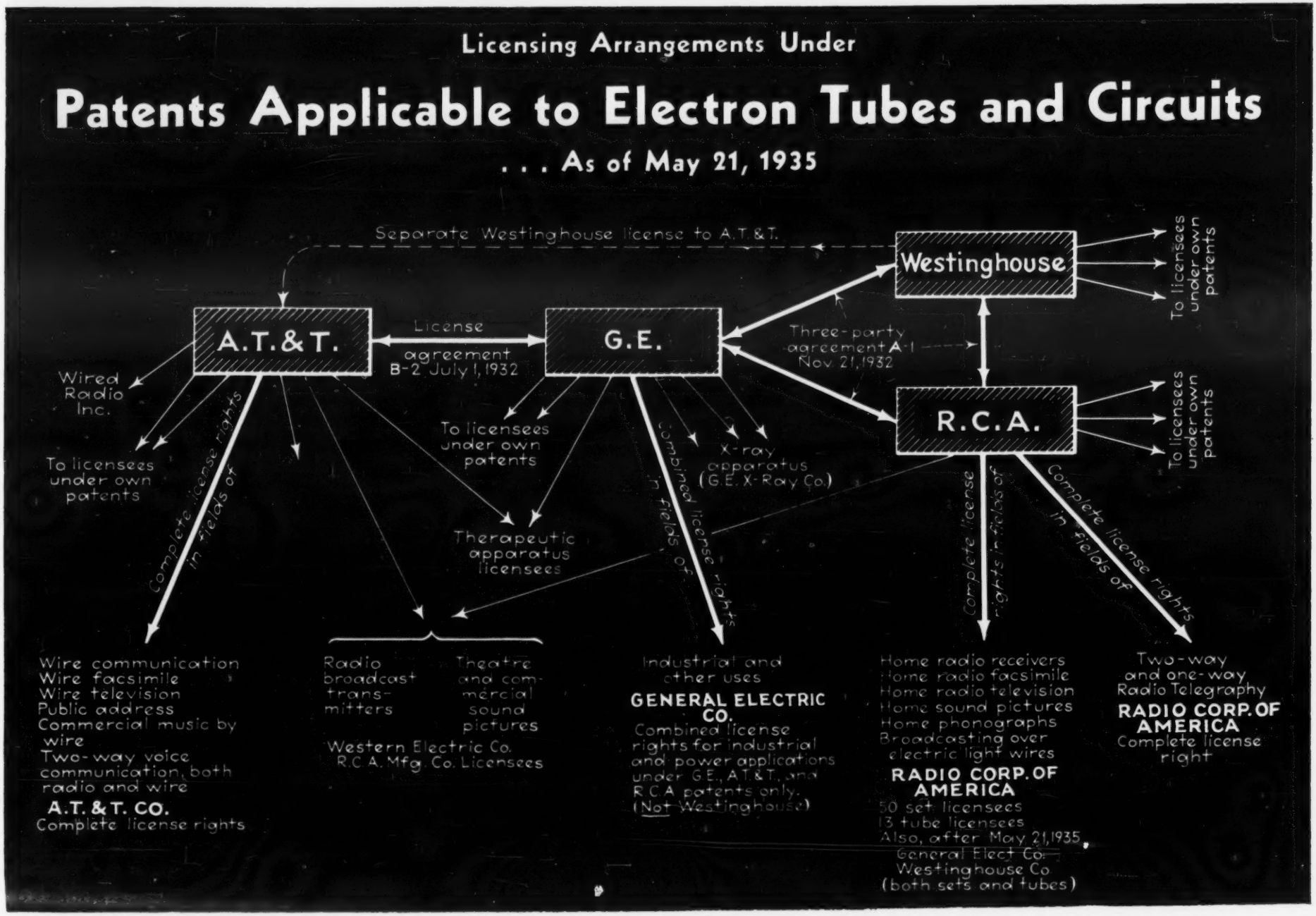
In this issue will be found description of the new antennas, new types of construction, new filters to keep out noise, new receiver circuits.

Cathode ray tube applications

Industry now finds it has a new tool, the cathode ray tube in which electrons were first discovered, long only a laboratory instrument. Speed, weight, pressure, velocity, distance, all can be measured in addition to the electrical quantities.

In June . . .

IRE ANNUAL CONVENTION SPECIAL ISSUE—June *Electronics* will cite the progress of the art since the last convention, will reveal new plans for the broadcasting system, will disclose circuits to be found in the most advanced receivers.


Licensing Arrangements Under
Patents Applicable to Electron Tubes and Circuits
. . . As of May 21, 1935
Separate Westinghouse license to A.T.&T.
Westinghouse
To licensees under own patents
A.T.&T.
License agreement B-2 July 1, 1932
G.E.
Three-party agreement A-1 Nov. 21, 1932
R.C.A.
To licensees under own patents
Wired Radio Inc.
To licensees under own patents
To licensees under own patents
X-ray apparatus (G.E. X-Ray Co.)
Therapeutic apparatus licensees
Complete license rights in fields of
Combined license rights in fields of
Complete license rights in fields of
Complete license rights in fields of
Wire communication
Wire facsimile
Wire television
Public address
Commercial music by wire
Two-way voice communication, both radio and wire
A.T. & T. CO.
Complete license rights
Radio broadcast transmitters
Theatre and commercial sound pictures
Western Electric Co.
R.C.A. Mfg. Co. Licensees
Industrial and other uses
GENERAL ELECTRIC CO.
Combined license rights for industrial and power applications under G.E., A.T.&T., and R.C.A. patents only. (Not Westinghouse)
Home radio receivers
Home radio facsimile
Home radio television
Home sound pictures
Home phonographs
Broadcasting over electric light wires
RADIO CORP. OF AMERICA
50 set licensees
13 tube licensees
Also, after May 21, 1935,
General Elect Co.
Westinghouse Co
(both sets and tubes)
Two-way and one-way Radio Telegraphy
RADIO CORP. OF AMERICA
Complete license right

THE ELECTRONIC LICENSE SITUATION

Company agreements under the Consent Decree
Complete sub-licensing rights in special fields

MAY 21, 1935, will mark the completion of the scope of the licensing plan contemplated by the inter-company agreements growing out of the Consent Decree in the Federal suit against the Radio Corporation, the General Electric and Westinghouse companies, and their associates. For on May 21, as the last step in carrying out the plan, the General Electric and Westinghouse companies will be automatically given licenses to re-enter the fields of radio-broadcast receiver and tube manufacturing. Both companies had been excluded from these fields for two and one-half years from the date of the decree.

So many inquiries have been received by the editors of *Electronics*, asking about the conditions of licensing under the interchange of tube and circuit patents by the four large companies concerned, that a brief general picture of the license situation as it will appear after May 21 of this year, may be helpful.

As shown by the accompanying diagram, each of the principal companies is free to grant non-exclusive licenses under its own patents, in any field. This was the condition insisted on in the Government's suit.

In certain specified fields, however, particular companies are authorized to grant to sub-licensees "complete rights" to pertinent patents of all four companies, through authority obtained from licensing interchanges, as indicated, between the four large principals. Thus, for example, the American Telephone & Telegraph Company can license applicants for wire communication, public-address, etc., *under all pertinent patents* of the General Electric Company, the Westinghouse Company, and the Radio Corporation, in addition to its own A. T. & T. patents.

Similarly, an applicant desiring a license to make home radio receivers or other home-entertainment devices, can apply to the license bureau of the Radio Corporation (RCA Building, Rockefeller Center, New York City) for a comprehensive license under the several thousand patents of the four principal companies. Or he may, if he chooses, apply to the four companies individually for licenses under their own patents.

The two basic agreements

The present arrangement replaces the former "exclusive license" patent agreement to which the Federal Government made objection. The suit brought by the Department of Justice was settled Nov. 21, 1932, by a consent decree which approved the two main agreements which make up the present licensing arrangement.

The first of these license agreements, known as "Agreement B2," and originally drawn up July 1, 1932, provided for the non-exclusive interchange of patent rights between the A. T. & T. Co. and the G. E. Co. Later, with the further approval of the court, licenses received under this agreement on the G. E. side, were extended to the Westinghouse Company and Radio Corporation, under a three-party "Agreement A1," dated Nov. 21, 1932.

These agreements provided that each company is free to license applicants under its own patents. In addition, the four companies agree to exchange licenses, and in some instances include the right to grant sublicenses in certain specified fields as the chart indicates.

Thus, as shown by the sketch, the A. T. & T. Co. is the only one of the group which can grant licenses under all of the patents of the whole group in the fields relating to wire commu-

◆ ◆

MAIN POINTS TO REMEMBER

Each patent-owner is free to grant non-exclusive licenses under its own patents

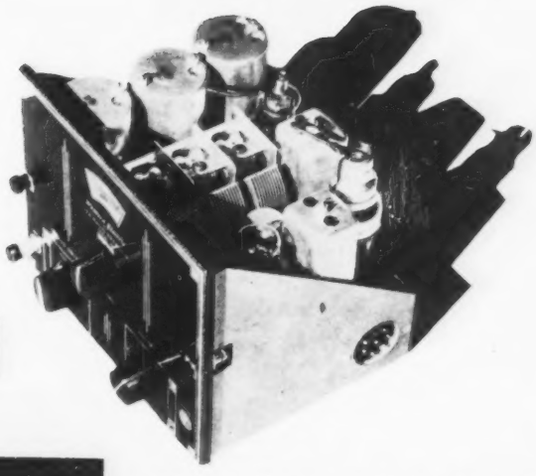
In certain fields specified companies have "complete rights" to license applicants under the patents of the several companies

Licenses apply to any pertinent patent useful in electronic circuits, whether originally taken out as pertaining to the electronic field or not

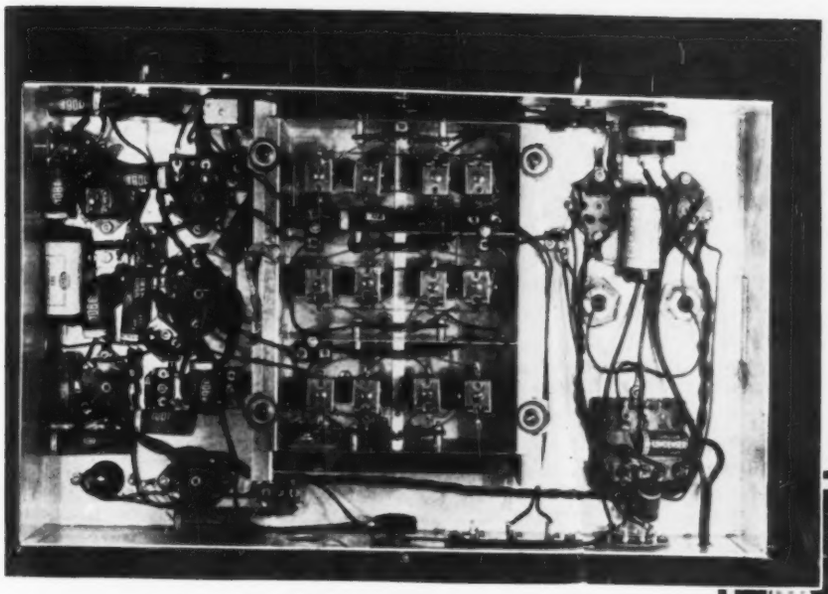
License policies under Consent Decree are embodied in two basic agreements: "B-2", July 1, 1932, between A. T. & T. and G. E. companies; and "A-1" Nov. 21, 1932, between G. E., Westinghouse, and RCA

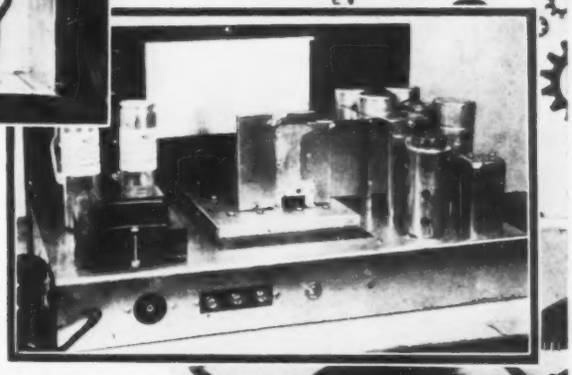
Present agreements continue in force until Dec. 31, 1954, and cover all patents owned or acquired by the parties. For patents issuing in 1954, the influence of the agreements will thus be continued until 1971

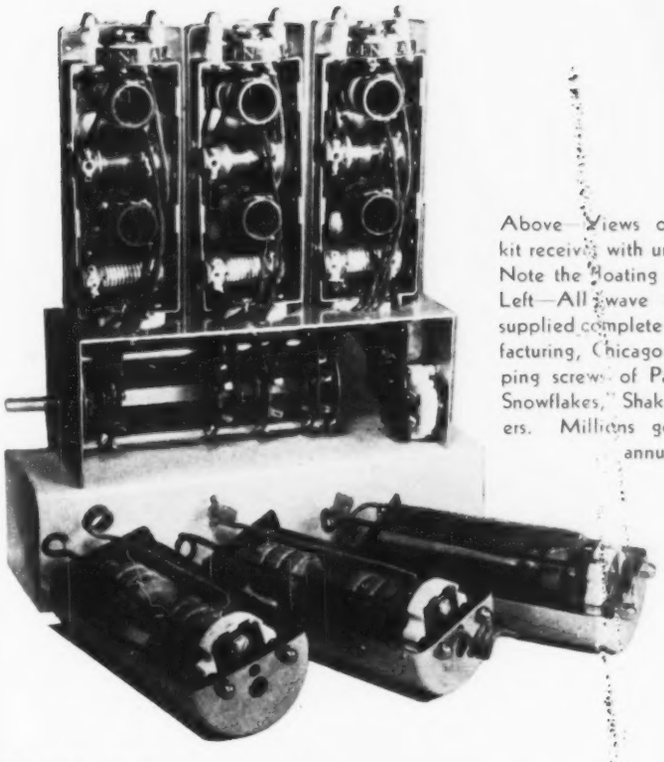
NEW RADIO RECEIVER CONSTRUCTION



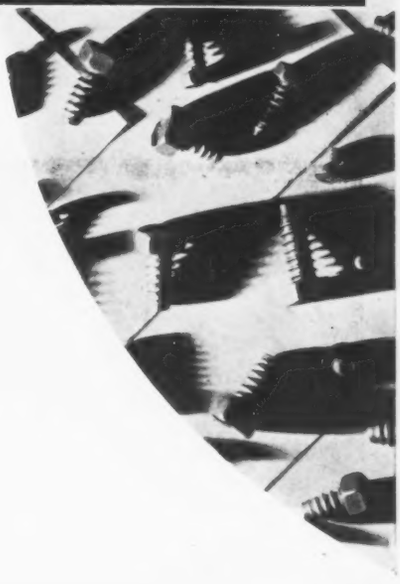
Western Electric 17-A superheterodyne receiver for itinerant fliers. Weighs 11 pounds. Covers 200-400 and 550-1500 kc. With 3 tubes produces 600 mw. output. Sensitivity of 10 μv.







Above—Views of Tobe Tuner, a kit receiver with unique construction. Note the floating tuning mechanism. Left—All wave tuning mechanism supplied complete by General Manufacturing, Chicago. Right—Self-tapping screws of Parker Kalon; "Iron Snowflakes," Shakeproof Lock Washers. Millions go into radio sets annually



nication in any form (including voice, facsimile and television), public-address systems, the transmission of music by wire for commercial purposes, broadcasting of programs over wire lines (except over electric-light wires), and two-way voice communication of any kind, either radio or wire. This does not mean, however, that an applicant who desires to obtain a license under a patent or patents of one of the other companies, in any of the fields just listed, cannot apply directly to the owner company and there obtain his license if the owner company is willing to grant such license.

Each can license under own patents

In the same way, the A. T. & T. Co. is free to issue licenses under its own patents in these or any other fields. It has, for example, just completed an exchange arrangement of patents with Wired Radio, Inc., the subsidiary of the North American Company, which is carrying on experiments with the broadcasting of entertainment programs over electric-light wires. In this case, Wired Radio's license is only for patents owned by the A. T. & T. Co. (For license to use the patents of all four companies for broadcasting over "electric-light, heat, power, and traction wires," application would have to be made to the R. C. A., which has complete sub-licensing "rights" for this field.)

Licenses for industrial applications of electron tubes and circuits, under the patents of A. T. & T. and R. C. A., are obtainable from the General Electric Company as licensor. Each of the companies is still free to issue licenses in this field, of course, under its own patents. In the field of X-ray apparatus, the General Electric Company can also license under the patents of A. T. & T. and R. C. A. The G. E. subsidiary operating in this field, the G. E. X-Ray Company, is a licensee, and further licenses issued in the X-ray field, if granted, would come directly from the General Electric Company.

On the other hand, patents on therapeutic apparatus are held by the A. T. & T. as well as the G. E. and an applicant in this field might find it necessary to take out licenses from both companies, since there is no central licensor authority for the therapeutic field.

Broadcasting and home entertainment

A similar relationship applies to both the broadcast transmitter field, and the sound-picture field, both theatre and industrial. In these fields the Western Electric Company (the A. T. & T. subsidiary) and the RCA Manufacturing Company (the RCA subsidiary), are the only licensees, by reason of cross licenses between their parent companies, but neither of the latter have granted sub-licensing rights to the other.

Licensing in the home-entertainment field is concentrated in the Radio Corporation of America, which is thus in position to issue licenses under all patents of the group, to applicants desiring to manufacture home radio receivers, home radio facsimile printers, home radio television receivers, home sound pictures, home receivers taking programs from the electric-light wires ("wired radio") and home phonograph apparatus. At present the RCA license division has licenses outstanding to 50 receiving-set manufacturers and to 13 tube manufacturers. Added to this list, after May 21, by the terms of the consent-decree agreement, will be the General Electric Company and the Westinghouse Company, each with authority to make both sets and tubes.

Radio telegraphy and police service

The Radio Corporation is also the full-rights licensor in all fields of radio telegraphy, both one-way and two-way. "Radio telegraphy," as defined in the agreement, includes all forms of "radio signals," such as facsimile and television, but *not* voice communication (which is reserved by A. T. & T.).

Not shown on the chart is the field of police radio. By an original interchange of their own patents, the RCA and Western Electric Company were authorized to operate in police radio from the beginning of the agreement. On Nov. 21, 1933, under the agreement, the General Electric and Westinghouse companies became authorized to enter the police field also. When, however, these companies now make two-way voice police systems, it is only by special consent of the A. T. & T., which controls the whole two-way voice field in both radio and wire communication, as already pointed out.

In the government field, by an interchange of patents, the RCA, Western Electric, G. E. and Westinghouse companies, are all authorized to build government radio apparatus. Licenses for others to enter the government radio field can be obtained from the individual patent owners, or through the channels having complete license rights for telephone and telegraph use.

Scope and life of present license agreements

Where complete license rights are granted to a sub-licensee the license thus issued covers not only patents specifically relating to tubes and tube circuits, but includes also rights under any pertinent patent held by any of the companies, which patent may be applicable or necessary in the work of the field defined. For instance, one of the patent-owning companies might have a switch patent which originally was taken out without any reference to radio or electron-tube circuits. But a licensee obtaining rights to the group patents for, say, home facsimile, would be entitled to the use of this hitherto unrelated patent, if he found that it became applicable in building his home facsimile receiver.

Under the terms of the agreements between the four companies, there are included in the license exchange all patents which the companies own or may acquire during the life of the agreement. Included also are any rights under patents which may be acquired by lease or royalty in the future.

The present license agreement is to continue in force until Dec. 31, 1954, and so long thereafter as patents subject to the agreement remain unexpired. Thus, as to patents issuing in 1954 the licenses of the agreement will continue for the life of such patents seventeen years further, or until 1971.

Where to go for licenses

The license bureau of the Radio Corporation of America is located at the corporation's main office, RCA Building, Radio City, 30 Rockefeller Plaza, New York City.

License matters for the General Electric Company are handled by the company's patent department, 1 River Road, Schenectady, New York.

Licenses issued by the American Telephone & Telegraph Company come either through the patent department at the main office, 195 Broadway, New York City, or in some cases through the license bureau of the office of its subsidiary, Electrical Research Products, Inc., 250 West Fifty-seventh Street, New York City.

Westinghouse patent matters are handled from the company's headquarters office at East Pittsburgh, Pennsylvania.

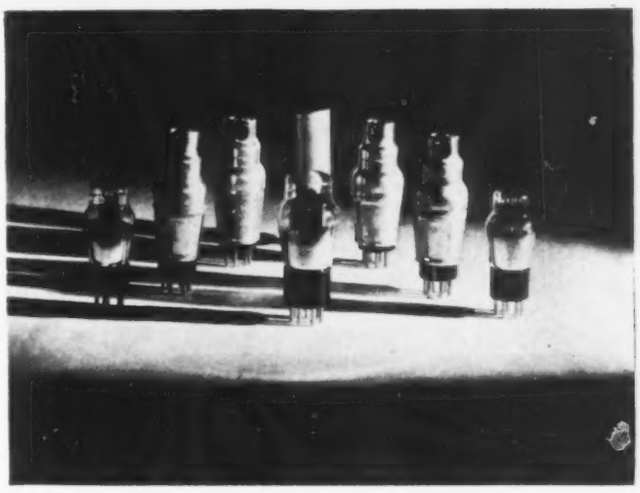
double shielding of the chassis. Here the portions of the chassis affected by noise, the tuning mechanism for example, are separated electrically and mechanically from the remainder of the set. The shield containing this portion of the chassis is grounded to the outer shield at only one point.

Battery leads are specially filtered. In the RCA Victor models a special input circuit accepts broadcast signals and offers a considerable objection to the development of voltages below and above the 550-1500 kc. band. This input circuit is doubly resonant, by series resonance to the lower frequency end of the desired spectrum, and by a conventional anti-resonant circuit to 1500 kc. Thus this circuit builds up a band-pass effect.

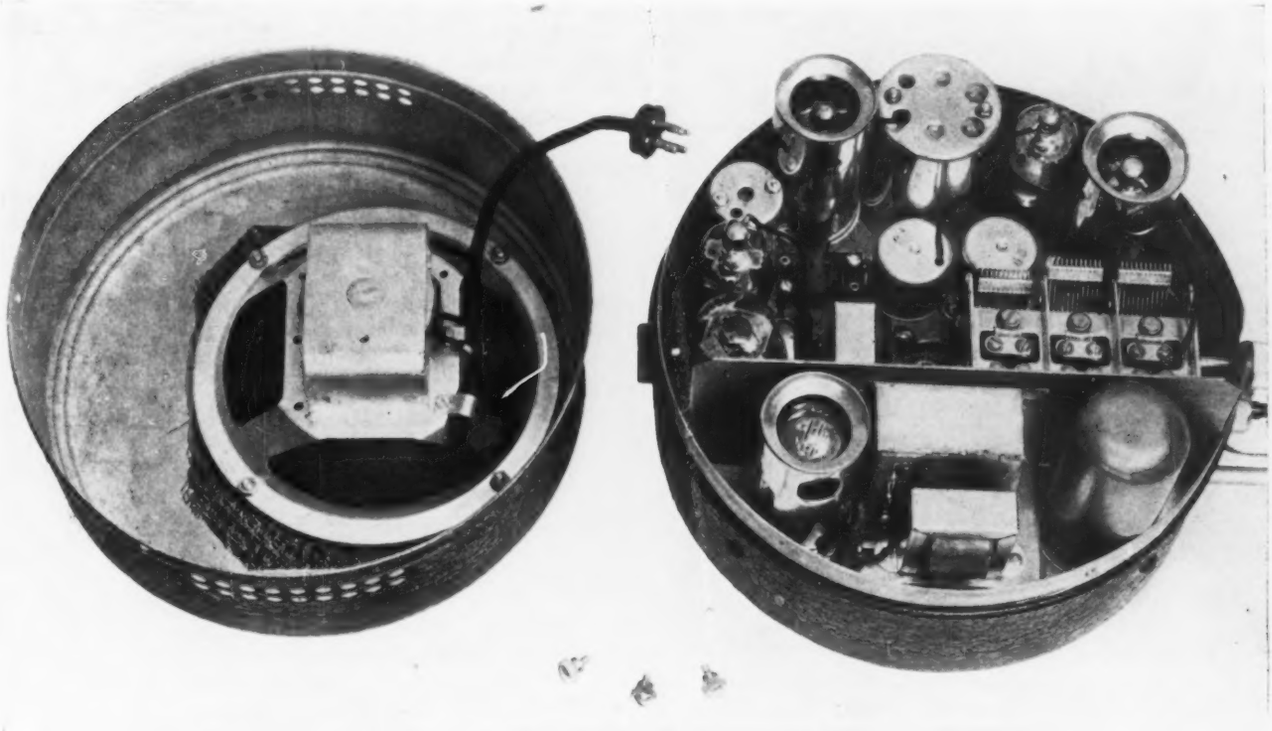
In filtering modern auto radio systems, shunt capacities must have short leads and must be capacitive at the interference frequency. The dielectric must be of good quality. Flexible shafting is now connected mechanically to the controlled mechanism. The metal portions of this shafting do not enter the receiver chassis compartment. Thus noise picked up by the cable cannot enter the sensitive portions of the set. In some circuits the input transformer primary is not grounded to the chassis but is continued by a twisted pair back to the point where the antenna enters. At this point the one terminal of the pair is grounded. Thus circulating currents cannot appear across the input primary except in reduced amplitude compared to what happens when a conventional grounded primary coil is utilized.

In some receivers special tone correction has been employed to overcome the handicap of small baffle areas, and to make more intelligible speech or other program material where the higher frequencies are useful. Thus both bass compensation and bass elimination are at times offered the listener. On speech the bass is reduced so that under noisy conditions the higher frequencies only are permitted to issue from the loud speaker. It is well known that intelligiblity is a function of the high frequencies, carrying power being a function of the lower notes. Furthermore the loud speaker is often installed overhead now so that the air path to the listeners' ears is shorter requiring less power and enabling the loudspeaker more easily to override car noise.

All in all, automobile radio, 1935 model, looks better than it has at any time in the past. The listener has a really good chance to get an excellent product in which engineering of an advanced nature has played a prominent part.



Form-fitting shields (Goat) help to prevent ignition noise from entering the program circuits and causing interference



"Round for Sound" is the United American Bosch slogan for 1935 auto-radio. Compactness in mechanical design coupled with good shielding is required of receivers for car operation today

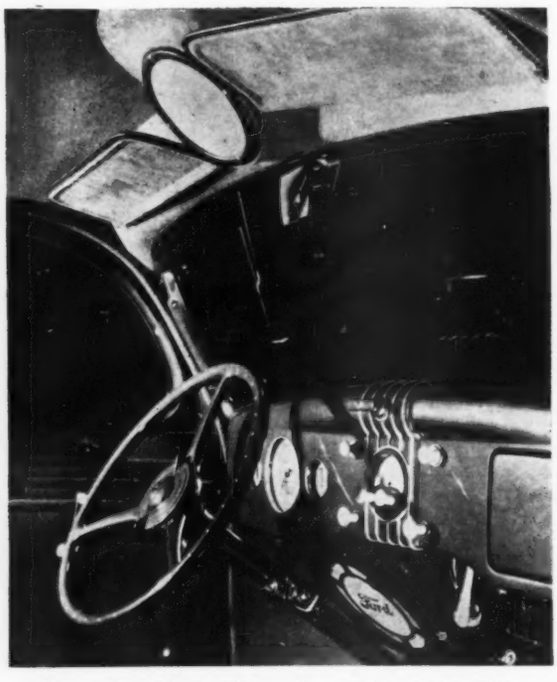
AUTOMOBILE RADIO

1935 MODEL

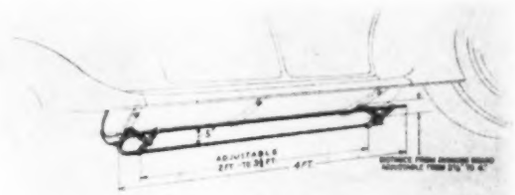
TECHNICAL descriptions of the new automobile radios, 1935 models, make evident the fact that engineering has entered this important phase of the radio industry; and entered in a big way. Not only have important changes been made in the cars to mitigate interference from ignition systems, but radio engineers have made a determined effort to see what could be done with the radio receivers themseives to shut out even the reduced noise output of modern cars.

New antennas, new transmission lines, new methods of shielding the chassis, new placements of ignition apparatus have resulted from a concentrated campaign for better auto radio. At present it seems that very few spark suppressors will be used in modern cars, and even this number will decrease as time goes on.

An accumulation of gains has been made in the fight against ignition noise. The coil, for example, has been moved away from the radio receiver, at the behest of radio engineers. It has now been placed forward with the engine and under the shielding effect of the hood. High tension and low tension leads have been separated. High tension leads have been made shorter. Engineers have determined the range of wavelengths generated by the ignition system. Having learned this wavelength, they know how to handle the interference so that its broad band output affects the receiver to the smallest extent. But in learning these things radio engineers have discovered that an auto radio is not just any old radio stuck in a car. It must be specially engineered for its special province; it must be specially constructed and installed.



Custom-built Ford radio receiver. Note loud speaker installed above rear-view mirror



RCA Victor under-car dipole antenna, rejects ignition noise, accepts broadcast-band programs

In the line of antennas the RCA Victor under-car doublet is interesting in that it shows the application of engineering principles to a rather tough problem. Turret top cars make it necessary to place the antenna somewhere other than in the roof of the car. Placed under the running boards the antenna must act as a potential divider. If far from the car, near the ground, it gets good pick-up because of the greater effective height. If near the car, far from the ground, it gets much less of the voltage developed between car and ground. Studies indicate that an under-car antenna must not be more distant from the running boards than 4 inches, or trouble will develop on rough roads.

The antenna is exposed to the radiation of the ignition system and all conductors which are shocked into radiation by this system. Thus the old problem of signal-to-noise ratio comes up again. Engineers have determined that the ignition racket is strongest in the region of from 2 to 11 meters. The median wavelength is about 7 meters. Therefore, RCA Victor engineers have constructed a half-wave antenna resonant to 7 meters. This is folded back on itself as indicated and the lead to the receiver is taken from the exact center. Ignition noise produces equal and opposite voltages on the two halves of the antenna so that little of these voltages flow through the mid-tap to the receiver and back to the car through the ground or shield connection. On the other hand broadcast signals look at the antenna as two wires in parallel and produce their desired reaction on the receiver. This antenna is not quite so good as a roof antenna in pick-up, but is reported to represent a better signal-to-signal-noise ratio.

Among other tricks in the warfare against noise is

All-metal receiving tubes

The industry viewpoint

JUDGING from opinion voiced in the advertising pages of great national dailies, there is little to be said in favor of the metal receiving tubes. Certainly they made their unheralded appearance at a most embarrassing time, when the trade was about to be introduced to new lines of merchandise (using glass tubes) for Fall sale. Coming after a drastic reduction in tube list prices, the announcement on April 1 of a totally new line of tubes was an unpleasant surprise to many elements of the radio family.

Criticism of the new tubes and their mode of construction was promptly aired, evidently in an attempt to scare off the public. Some feel this declaration of misbelief in the new art only served to attract public attention with the result that people about to buy new receivers might feel it wise to wait. Some remember that well known engineers were quick to voice their lack of enthusiasm when screen grid tubes were first announced; and others harked back to the days when the power pentode was publicly called a disturber of the radio peace, and no contribution to the art.

There is complaint that some of the all-metal tubes so far produced, have been burned at the weld, causing leakage. This welding operation has to be handled very carefully, to insure a complete contact and to prevent burning and consequent highly undesirable loss of vacuum.

Three of the men chiefly responsible for the unique features of the metal receiving tubes:—G. F. Metcalf (left), J. E. Beggs and R. J. Bondley, grouped about a seal-making machine. Mr. W. C. White, whose photograph appears on the cover, directed this development

One radio engineer feels that the criticisms directed against the metal tube in certain public statements, are all points very well substantiated—in 1935! But he questions whether in the course of events in engineering developments, quite the reverse may not be the case in 1936 or 1937! In other words, time is on the side of the metal tube, and if it has present short-comings in manufacture, these will be corrected before many months.

The position in which the metal tube finds itself is something like that of the automobile. The early horseless carriages followed closely the design and construction of their horse-drawn buggy predecessors. It is really not until the last few years that the automobile has been wholly designed as an automotive vehicle, rather than as a modified carriage. Glass tubes have clung equally tenaciously to the materials and forms of the incandescent lamps from which they sprang. But now the new metal tube represents a design advance comparable to the stream-lined air-flow auto.

Automobiles had many critics and detractors—in 1907. Then it was not uncommon to find everywhere prophets of a gloomy future for the auto, in comparison with Dobbin. "Get a horse!" was familiar to embarrassed motorists of those days, when the motor failed to mote. But today automotive transportation rules the roads.

The great linear length of weld in each metal tube, is pointed out as tremendously increasing the opportunity for leaks, as compared with the pinch-glass construction. Each lead-in in an all-metal tube has three concentric circles of vacuum-tight joint surrounding it. The first circle is about $\frac{3}{16}$ inch in circumference, the next $\frac{5}{16}$ and the third $\frac{7}{8}$. In a seven-prong tube, there is thus nearly an inch of possible leakage line around the lead-ins. Another $3\frac{1}{2}$ inches is added by the case weld, making $4\frac{1}{2}$ inches in all. Compare this with the $\frac{1}{4}$ to $\frac{1}{2}$ in. total "contact" length of a comparable pinch-glass lead-in.

One tube manufacturer reports that the views of his factory and production men were anything but favorable when first shown the tubes, but that after studying them they felt that the new type of construction is the most sensible that one could imagine. They feel the steel cased tube to be a good manufacturing proposition, much more foolproof than glass tubes, more in tune with the times of mass production on automatic machinery.

Laymen, shown the tubes and asked to compare them with glass tubes when placed in a receiver, state that a row of black metal "bulbs" look more business-like than when made of glass. Others might easily feel differently about the appearance; some might prefer them to be in brighter colors!

Tube supplies are limited. All that the Radiotron plant can make will undoubtedly be required by General Electric for the one or more models of its new receivers built around them. Other tube manufacturers will find it costly to get ready to make metal tubes. Estimates show that to set up a single line, say 300 tubes per hour, would cost about $35,000. Full production schedule would call for four such lines, or something over $100,000.

The latter part of April witnessed a decided swing on the part of receiver manufacturers in favor of metal-tube sets for this Fall. Although these same manufacturers were apathetic at the first announcement of the metal tubes, pressure from sales departments (some of which have been thrown into a veritable panic about "being left behind the procession") has produced a change in plans. It now appears that at least a dozen radio sets will be on the market this Fall, featuring metal-tube operation.

Tube makers are also getting ready for all-metal production, but the fastest schedule of delivery for the new tube machines, probably sets August 1 as the earliest date for metal-tube delivery by these makers. This means that the metal-tube sets can be ready October 1, although the publicity and advertising on these new sets will probably start full-blast by September 1. The tube makers feel that the first companies to be able to make deliveries will have considerable advantages for this year's business.

Meanwhile some of the tube companies which do not want to make the $100,000 investment in new tube machinery required for all-metal output, are developing "hybrids"—tubes with glass envelopes and metal-type bases. These will be offered either as an intermediate service or for replacements in the future metal-tube sets.

The editors of ELECTRONICS believe that the following article by Messrs. Metcalf and Beggs will answer many of the questions that are being asked about the metal receiving tubes.

The manufacturing technique

by G. F. METCALF
and J. E. BEGGS

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Schenectady, N. Y.

STEEL construction has finally allowed the radio receiving tube to throw off its cloak borrowed from the incandescent lamp industry to take on a new one especially designed to fit its own requirements. The glass bulb of present-day receiving tubes is of little value other than as a vacuum enclosing envelope which often requires an internal conducting coating as well as an external shield can. A metal envelope performs all of these functions and in addition makes the tubes physically smaller and mechanically stronger. A metal container has often been proposed for receiving tubes, but in all cases where it was applied its use was limited by the feather-edge metal-to-glass seal which requires costly manufacturing methods and by the necessity of bringing all leads out one end.

The development of metals which have substantially the same expansion coefficient as certain special glasses and the use of special forms of control for the accurate and short timing of resistance welding have made possible an entirely new method of vacuum tube construction. By the application of this technique radio receiving tubes may be constructed from ordinary steel and assembled by automatic machinery. Leads may be brought through the metal envelope at any point which is necessary in order to obtain the best electrical characteristics. The use of welding has allowed the exhaust tubulation to be made of metal, the "welding-off" of this tubulation requiring only a fraction of a second.

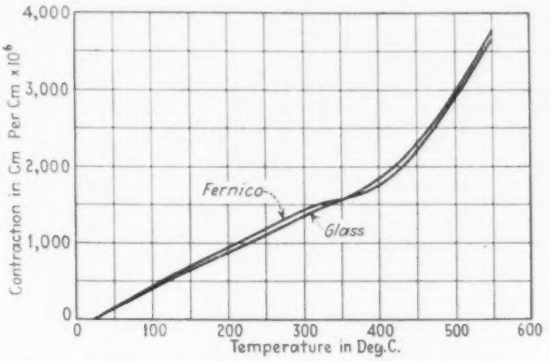


Fig. 1—Expansion of special glass and Fernico alloy

One of the most important elements in metal tube manufacture is the use of concentric type of metal-to-glass seals. This seal requires a minimum amount of glass and permits great mechanical strength. To construct seals of this type it is essential that the coefficient of expansion of the metal and glass be substantially the same over the entire temperature range encountered in their manufacture. Figure 1 shows the expansion characteristics of two such materials. This curve illustrates how the coefficients of expansion follow one another beyond their linear portions.[1] It is this feature which makes it possible to eliminate the feather-edge seal.

Alloy eyelets are inserted into holes punched in a steel disc and copper brazed or welded in place to form a bottom header for the tube. A lead wire, together with a small cylinder of glass, is inserted in each eyelet and the seals are made in an automatic stem machine. The metal exhaust tubulation is then welded in place, the support members are welded to the head, and the unit is ready for the mount. This unit is shown in Fig. 2, where it is compared to a typical glass stem. The internal elements are mounted on this stem in a

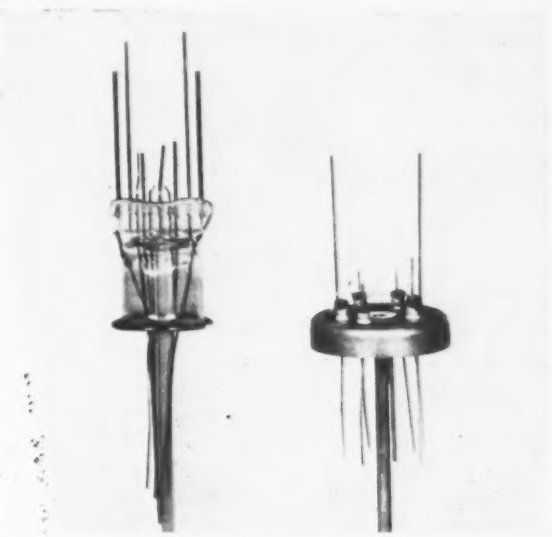


Fig. 2—Comparison of typical glass and metal stems

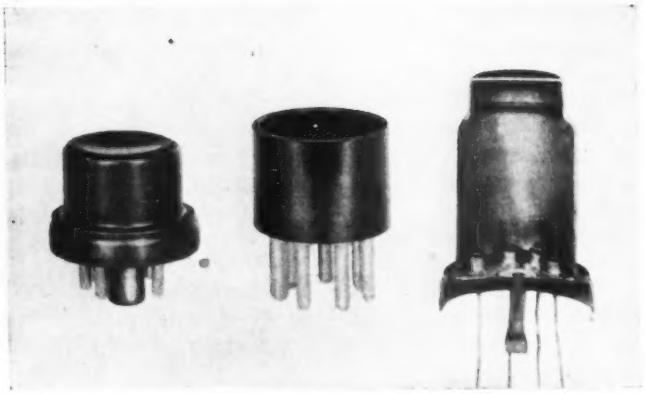


Fig. 3—Double diode compared to a small 7-prong base. Metal envelope cut away to show seals, exhaust tube, and projection weld

manner similar to the present glass tube technique. In this construction, however, it is possible to weld support members directly to the header so that a very sturdy assembly is possible.

The use of soldering, brazing, or arc welding to seal the metal container over this mount is not practical due to the contamination which would result from the heating of the internal elements. This problem has been overcome by the development of a large circumferential projection weld. This weld is made by the use of hollow electrodes in a large spot-welding machine controlled by Thyratron tubes. Such welds require only 1/20 to 1/30 of a second and have been made in the factory at the rate of nearly 1 a second. This type of weld has the advantage of causing little or no oxidation of the inner surfaces of the metal container, thus simplifying the exhaust procedure.

The tube is exhausted on an automatic exhaust machine. This allows much simpler equipment to be constructed. After exhaust, the tube is sealed off by first collapsing the exhaust tubulation between two electrodes and then welding it closed.

Figure 3 shows a section of this complete metal envelope. The projection weld of the shell to the head is shown, as are the eyelet type seals and the welded-off exhaust tubulation which are secured to the head. This shows the simple and substantial vacuum-tight envelope that is the basis of "all metal" radio tube construction.

One of the most apparent features of metal radio tubes is small size. Figure 4 compares a metal tube of the r-f pentode type with a standard glass tube of similar function, and shows the reduction in size realized by metal construction. That this small size is not a result of miniature internal parts or decreased electrode clearances is evident from Figure 5 which shows these tubes cut open to expose internal electrode structures of identical size.

The metal "stem" is one of the important factors permitting construction of a small tube. While the glass stem requires a skirt of tubing between the leading-in wire press and the flare to reduce the danger of cracks and strains when being sealed into a bulb, there is no need for this in a tube of metal construction since the stem and bulb are both made of steel and may be welded together without transmitting strains to the seal members. By eliminating this re-entrant form of glass stem, a reduction in the length of leads and tube is possible.

The steel shell is another factor permitting the construction of a small tube. The shell simultaneously performs the function of internal shield, bulb and external shield, causing a saving of space to be effected because of the elimination of parts. Also, since it is made of steel, it can be fabricated to very close dimensions, permitting its overall size to be made but a few thousandths of an inch greater in diameter than that necessary for design clearances.

The skirt on the metal stem is used solely for basing purposes. A moulded base disc is inserted into the skirt which is then peened over at several points to hold the base intact. This provides a very simple basing method which does not require the use of basing cement. The base is held solidly in place with no possibility of twisting or coming loose.

Simple basing technique

Another advantage of the metal stem from the standpoint of basing is the ability to locate the leading-in wires at advantageous positions not necessarily in a straight line or circle. The seal members, including the leading-in wires, can be placed where they are most useful. Accordingly, the leading-in wires are placed to coincide with their respective pins in the base, which not only facilitates threading but also permits the base to be attached close to the stem. This close basing, possible with a metal tube, effects a further reduction in size, allowing the use of a smaller base. To make connection to the shield conveniently, there is a lead to an additional pin in the base.

The top cap is mounted very securely to the tube in much the same manner as the base. The length of the tube is further shortened by this type of basing because the top of the shell can be made flat. Flat surfaces are not generally practical in glass bulbs because of the weakness introduced. In a shell made of steel, however, flat surfaces introduce no such handicap. This flat top permits a smaller fixed clearance to be used between the top of the mount and the top of the shell than is practical in a glass tube.

Better shielding possible by metal shells

Present circuit practice demands that the grid to plate capacity of a typical screen-grid tube be of the order of .010 μμf or less. To meet this requirement with tubes of glass construction, it is necessary to use external shield cans in conjunction with the tubes. In general, the shielding of this combination is at its best when the external shield fits the bulb very snugly. It would be more perfect, however, if the glass bulb could be removed from between the inner and outer shield

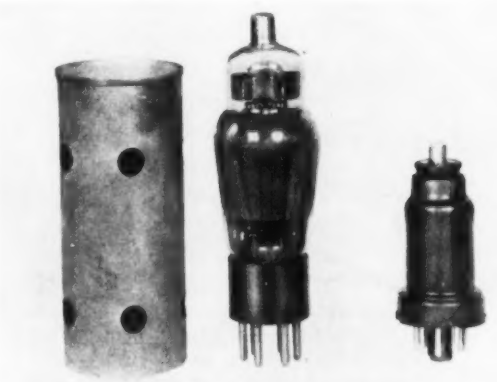


Fig. 4—Typical glass and metal r-f pentodes

members. This is the case in the steel tube, inasmuch as the shell is inner shield, bulb, and outer shield all in one. By referring to Figure 5, it will be noted that the top grid lead is completely isolated from the plate by the top grid collar and the shell, which together represent an uninterrupted shield member. Since there are no gaps in the metallic structure between grid and plate, an unusually low grid to plate capacity is attained. Also, the shielding is complete in itself, making it unnecessary to use an external shield can.

Metal tube construction eliminates trouble such as is caused by surface conditions inside bulbs of glass. Such effects are of considerable annoyance, especially at the higher radio frequencies. To overcome this defect in the glass tube, it is necessary to coat the bulb with a graphite preparation. Since the entire shell in a metal tube is necessarily at shield potential, this effect does not exist.

Strong internal construction; better radiation

The metal stem is ideal for supporting internal parts. It permits the entire weight of the electrode structure to be supported by members welded directly to the steel head. This removes the leading-in wires and seals from the role of support members—an impossible condition in glass tube construction. The top of the electrode structure is closely positioned by the steel shell which is domed or otherwise conveniently shaped to correct size to seat accurately the top of the mount. This secure lodging of the top of the electrode structure in conjunction with its solid support from the head produces a strong and rigid tube in which looseness of parts and microphonic troubles are minimized.

Figure 6 compares a typical power output tube of glass construction to a steel tube of similar characteristics. The steel tube, which operates with the shell as protective shield is considerably smaller than the glass tube and yet the power dissipating abilities of the two are comparable. The small size of the metal tube in this case is possible because the steel shell may be more efficiently cooled than may the glass bulb. The surface

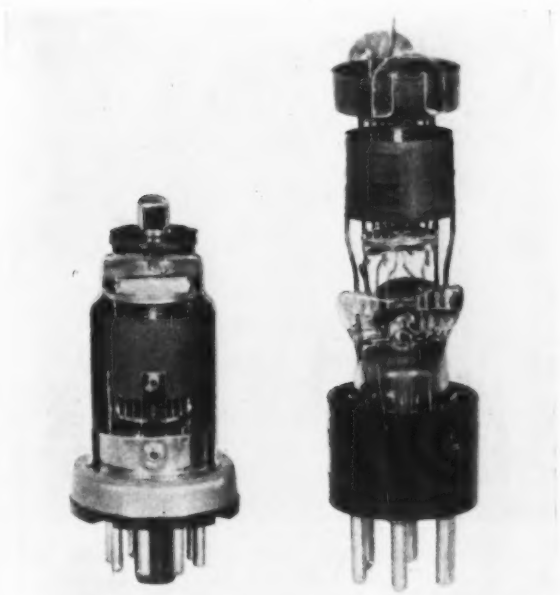


Fig. 5—Internal structure of metal and glass tubes of similar characteristics

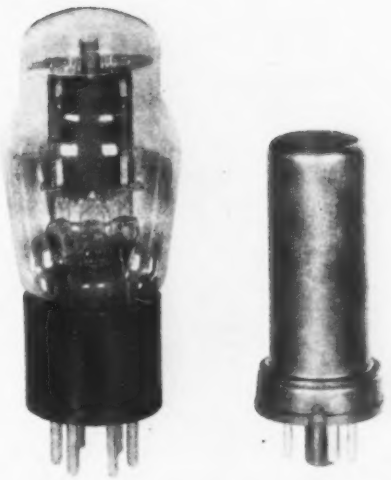


Fig. 6—Power output tubes of similar rating of the old and the new tube art

of the steel shell may be painted black or otherwise treated to improve its radiating ability. When necessary, fins may be added to increase the surface area and radiating efficiency.

In metal tubes, the temperature of the seals may be kept below the point where trouble is experienced from electrolysis more easily than in glass tubes. The reason for this is that the glass tube is subject to uneven temperature distribution as a consequence of the poor conductivity of the bulb. As a result, the seals may easily be the hottest part of the tube. On the other hand, the steel shell and stem provide reasonably good conduction of heat so that the whole tube, seals and all, operates more nearly at the same temperature. Thus, sufficient surface area may be provided to keep the seal temperature at a safe value. This better control of temperature, in conjunction with the better control of radiating efficiency, permits the design of small metal power tubes.

The steel tube should lessen the demand for dual purpose tubes. Figure 3 shows a twin-diode of "all metal" construction compared in size to a tube base. Here is a tube which, because of the reduction of size possible with metal construction, is small enough that it may be placed into almost any corner. Yet when operating as a diode detector, it is more efficient than most standard glass tubes, and may be used independently of other tubes in the circuit. The use of single purpose metal tubes permits the maximum design flexibility and functional efficiency to be obtained in the minimum of space. Thus, with single purpose tubes of such small size available, there is less need for the multiplicity of combination types with their inherently inferior characteristics and limited field of usage.

Several major developments, including resistance welding controlled by Thyratron tubes, strain-free leading-in seals and welded metal seal-offs, have made possible the manufacture of "all metal" radio tubes of but slightly larger size than the enclosed electrode structures. These new tubes have many improvements over their glass predecessors and combine mechanical ruggedness, small size and improved characteristics with simplicity of design. They are well adapted for modern methods of quantity production and open up new fields of design.

[1]Glass to Metal Seals—Dr. A. W. Hull and E. E. Burger, *Physics*, December, 1934.

WLW installs "blind spot" antenna array —aimed at Toronto area

INTERFERENCE suppression by means of directional antenna arrays, a comparatively new development in broadcasting, has been pushed one step forward with the installation of an unusual "suppressor" antenna for WLW's 500 kw station at Cincinnati. By its use the station is expected to resume full-time operation with 500 kw power, after several weeks of operation at a reduced power of 50 kw for night time service. The new antenna is designed to lay down a 50 kw signal in the vicinity of Toronto, Canada, and a 500 kw signal in all other locations within reach of the station.

Following complaints made by listeners of CFRB, a station in Toronto operating at 10 kc separation from WLW's frequency, that the high-power signal of the Cincinnati station was causing undue interference, the Canadian government made representations to the FCC, through the State Department, asking for a reduction of WLW's power output. At the request of the FCC, WLW has been operating at 50 kw output after sun-down. Under this arrangement ninety per cent of the power output of the station has been useless during the all-important evening hours, a situation which prompted the engineers of the station to develop an antenna system which would clear up the interference without reducing the power output below the full capacity of 500 kw.

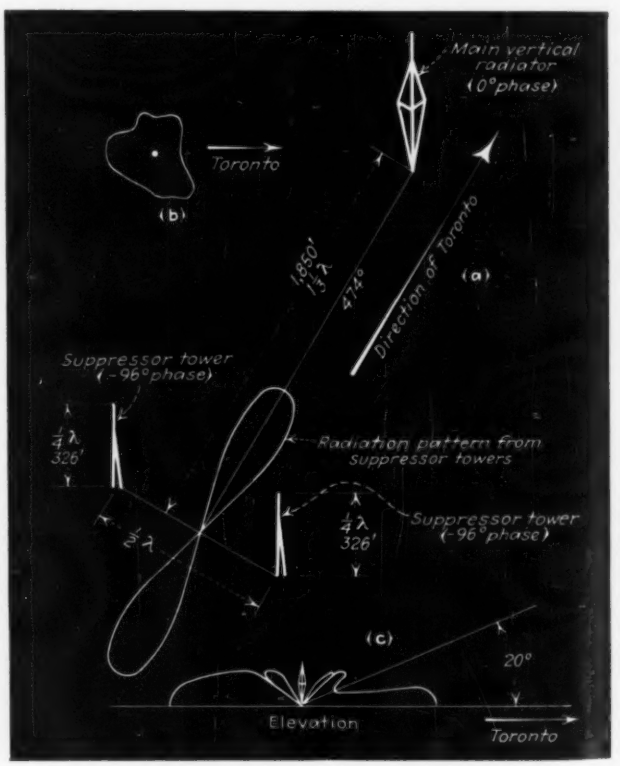
The system arrived at is an almost ideal solution to the problem, in that it reduces the interference in the locality from which complaints were received without reducing the signal strength in other localities. This is a distinct advance over previous methods of interference suppression using directive antennas, which reduced the interference in a given *direction* from station, rather than in a particular *locality*. In particular, the signal at Toronto and surrounding territory within a radius of 150 miles, is reduced to 50 kw, the power output of WLW before its increase to 500 kw, and under which no complaints were received.

According to J. A. Chambers, Chief Engineer of the station, WLW's secondary service area (that served by the sky-wave of the station) is much more important than that of lower power stations, since the sky-wave is powerful enough to give a useful service at distances up to a thousand miles or more. It was important, therefore, in designing the antenna system not to jeopardize the usefulness of the sky wave signal. Had a simple directional antenna been used, with a null point in the direction of Toronto the secondary service would have been subjected to severe fading from unavoidable wave-interference patterns. In addition, since a line from Cincinnati to Toronto passes through several important industrial areas in Ohio, the primary service would have been greatly impaired in this direction. Early in the development of the new system, therefore, it became clear that a simple directional signal was to be avoided at all costs.

Forced to a consideration of other possibilities, the engineering staff of the station started with the fact that the radiation which caused the interference in Toronto left the antenna of the station at an angle of 20° above the horizon, and was subsequently reflected into the Toronto area by the Heaviside layer. It was decided to suppress the radiation at the angle above the horizon in the direction of Toronto, and if possible to avoid suppressing the signal at any other angle, or in any other direction. The system finally worked out accomplishes this result by the use of two additional vertical radiators, fed with 85 kw power, and so placed with respect to the main radiator that the desired reduction of signal strength is obtained at the required angle. The cost of the additional facilities is estimated at $30,000.

Because the suppressor towers had to be erected during the daytime while the vertical radiator was transmitting 500 kw, considerable trouble was experienced with large radio-frequency currents induced in the steel of the new construction. For this reason all steel pieces had to

[*Please turn to page 159*]



This antenna system is designed to lay down a 50 kw. signal around Toronto and a 500 kw. signal everywhere else. (a) Dimensions and phasing of the array. (b) Ground-wave signal pattern. (c) Profile view of radiation pattern

Cathode-ray tube applications

By J. M. STINCHFIELD

RCA Manufacturing Company
Harrison, New Jersey

Cathode-ray tubes have long been used to measure voltage, current, and wave forms, or for comparing frequencies. There are other measurements, however, to which these electron guns may be placed which enlarge their usefulness tremendously.

SHORT time intervals, for example, may be measured by comparison with known frequencies. A pair of contacts may be periodically opened and closed by a vibrator. The frequency of the vibrator and the length of time the contacts are closed depend on the spring tension and the current to the vibrator. The contacts are connected through a B battery to one pair of deflecting plates of a cathode-ray tube. A linear time-sweep voltage is applied to the other pair of deflecting plates. The sweep frequency is adjusted until the pattern on the screen appears as a stationary rectangular wave. The ratio of the width of the wave to the total sweep gives the fraction of the time the contacts are closed. The reciprocal of the sweep frequency gives the total time of one cycle. The product is the time the contacts are closed. The effect of different amounts of spring tension and current may thus be determined. Any sparking or poor touching of the contacts is apparent in the pattern on the screen.

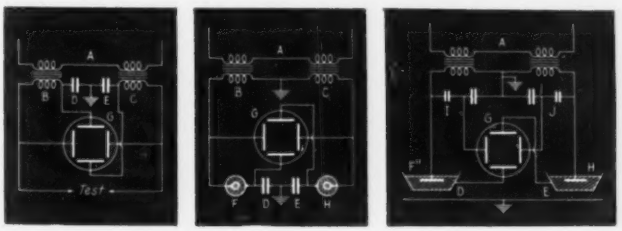


Fig. 1—Power-measuring circuits. Center, measuring loss in cable and, right, measuring loss in transformer oil

POWER may be measured by circuits suggested by Prof. H. J. Ryan.[1] The applied voltage is effective across one pair of deflector plates. The voltage drop through a capacitance due to the load current is applied to the other pair of plates. The area of the resulting pattern is proportional to the power. The proportionality constant is determined by connecting a known resistance load. The areas may be determined with a planimeter, or by cutting out the traced or photographed area and comparing the weight with that of known areas of the same material.

HIGH speed transients, the occurrence of which is fortuitous, as, for example, lightning surges, may be observed, but it is necessary to have the beam switched on by some arrangement controlled by the transient surge. Figure 2 shows a circuit used by R. H. George[2] for this purpose. The flow of beam current is prevented by the negative bias *C* on tubes *D* and *E*. The transient surge on the high-voltage line is picked up by the antenna *A*, coupled to the grids of the tubes *D* and *E*. Depending on the polarity of the surge, either tube *D* or tube *E* will have a positive voltage applied to the grid. This permits the beam current to flow for the duration of the transient. A sweep voltage may be operating continuously on the other pair of deflecting plates, or a single sweep controlled by the transient impulse may be used. The deflecting plate *G* receives the transient impulse through a potential divider coupled to the high-voltage line. In Fig. 2 below, this circuit is modified to control the bias on the control-grid of a cathode-ray tube. This arrangement has the advantage of low plate voltage on the tubes *D* and *E*.

LOUDSPEAKERS or other devices may be measured for impedance and power factor. Current *i* through

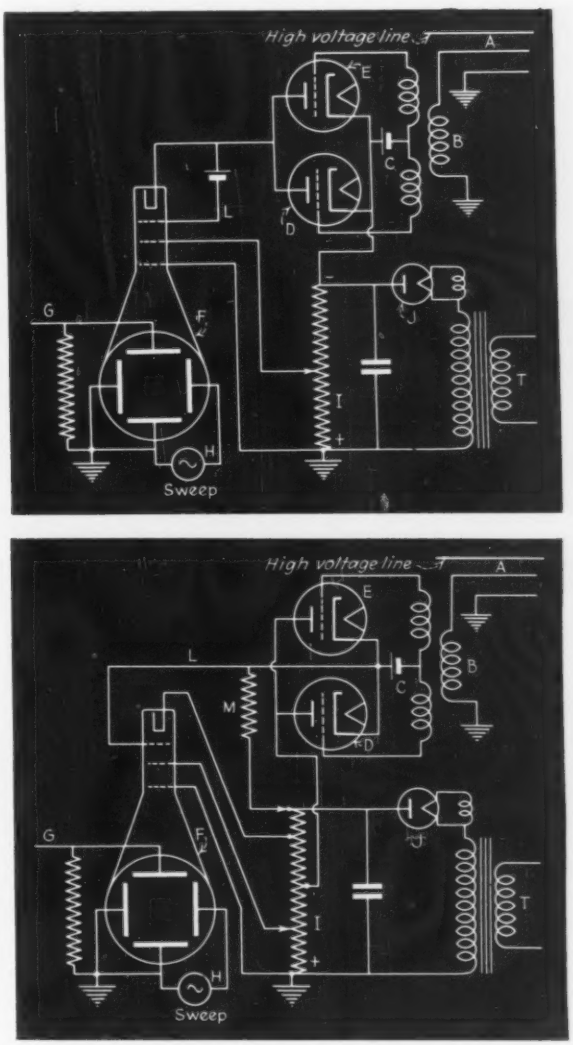


Fig. 2—Beam current controlled by transient, by anode circuit and below, by control electrode

the loudspeaker develops a voltage in R_1 which is connected to one pair of plates. The resistance R_1 plus R_2 is made equal to the internal plate resistance of the tube normally used with the loudspeaker. The voltage source E is equivalent to the effective internal voltage μe_g of the tube. The frequency and magnitude of E is varied and the resulting impedance and power factor noted. The impedance equals $K(AB/CD)R_1$. The phase angle ϕ and power factor cos ϕ are obtained from sin $\phi = (FG/AB)$. The factor K is equal to the ratio of the deflection sensitivities in the AB to CD directions. Since K is a function of the physical dimensions of the deflecting system alone, the anode voltage and calibration of the cathode ray tube need not be known.

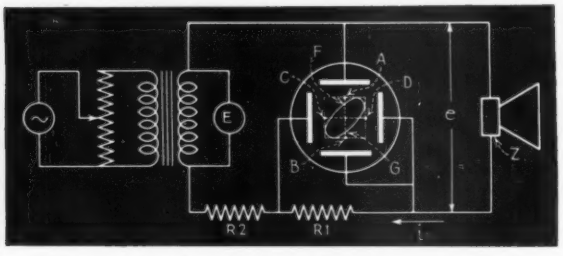


Fig. 3—Loudspeaker impedance measurement

SPEED may be measured with any precision desired and without imposing a load upon the device being measured. In Fig. 4, E is a rotating part of a machine, though it might as well have a reciprocating or other type of movement. A metal projection makes connection between two filamentary brushes as it passes. The voltage of the battery D is momentarily applied to the deflector plate F of the cathode-ray tube. A linear time-sweep generator or other voltage source of adjustable and known frequency is connected to the other pair of deflecting plates. When the pattern on the screen is stationary, the speed corresponds to the known frequency. When the moving part E is to be maintained at a constant operating speed, a tuning fork oscillator, magnetostriction oscillator, or other constant frequency source may be used. Any variation in speed is then clearly indicated by a movement of the pattern. The current through the filamentary contacts can be kept to a small fraction of a microampere, when a high-vacuum type cathode-ray tube is used, by maintaining the deflection plate F biased

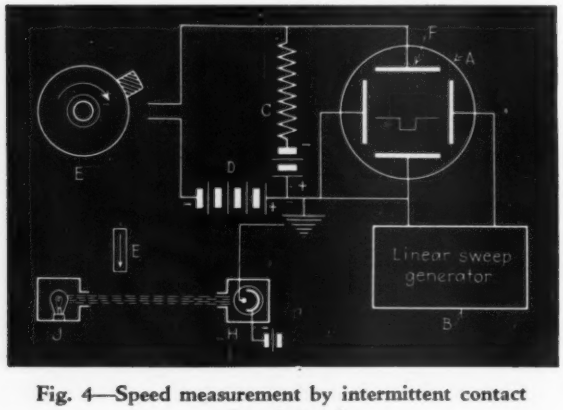


Fig. 4—Speed measurement by intermittent contact or by phototube

slightly negative through a 100-megohm resistor C and by connecting voltage D to make the deflection plate F just enough more negative to give an easily readable deflection on the screen. The speed measurement may be made without the contacts by arranging a light beam so that it is interrupted by the moving part. A photo tube translates the light beam interruption into an electric pulse which is applied to the deflector plates of the cathode-ray tube.

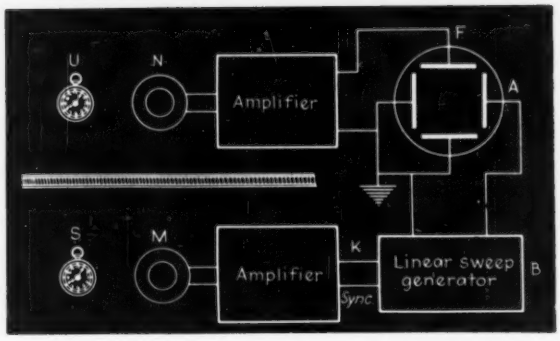


Fig. 5—Watch timing by comparison with standard

CLOCKS and watches may be compared. In Fig. 5 the generator is connected to one pair of plates of the cathode-ray tube and synchronized through the terminals K connected to an amplifier and microphone M. A standard clock S is located near M. The timepiece, the accuracy of which is to be checked, is situated near the second microphone. If the timepieces are nearly in synchronism with only a very small difference in speed, the pattern on the screen will appear to drift at a very slow and easily measured rate. From the measured rate of drift of the pattern, the deviation per day, month, etc., from the standard may be easily calculated.

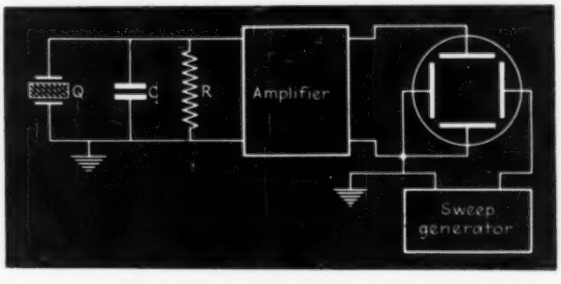


Fig. 6—Measurement of pressure variations with quartz crystal

PRESSURE fluctuations may be observed and recorded by Fig. 6. A quartz crystal Q is mounted between insulated electrodes arranged for insertion into the cylinder, chamber, or device in which the pressure fluctuations occur. Due to the piezo-electric properties of the quartz, a quantity of electricity is liberated by it proportional to the applied pressure. Voltage fluctuations will occur across the capacitance C directly proportional to the pressure on the crystal Q. To avoid error, R is made as high in resistance as possible and the capacitance C is made as large as it can be made without reducing the voltage too much. The reduction in voltage due to the increase in C requires that the amplifier gain be increased. The voltage may be doubled if desired by the use of two quartz crystals. The change in resistance of carbon with pressure, or the capacitance change due to the deflection of a diaphragm may also be used for converting pressure fluctuations into voltage fluctuations which can be applied to the deflecting plates.

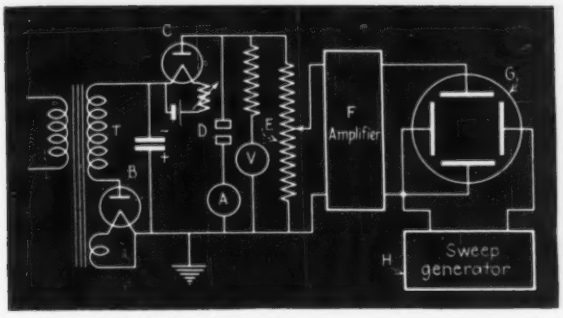


Fig. 7—Air-speed fluctuation measurement

AIR velocity fluctuations may be viewed by Fig. 7.[3] D represents a closely-spaced pair of electrodes. A d-c voltage is supplied to the saturated diode C, operated at a low filament temperature to maintain constant current through the electrodes D. Fluctuations in air velocity cause corresponding fluctuations in voltage across the electrodes D. The voltage fluctuations are applied through an amplifier to the cathode-ray tube.

COMPRESSION and fuel detonation characteristics in the cylinder of a gas engine may be indicated by Fig. 8.[4] Two small tungsten electrodes are mounted in an insulated plug B in the cylinder A. The electrodes are connected across the tuned circuit of an oscillator D. The radio-frequency voltage modulated by the effects of the compressed gas between the electrodes in the cylinder

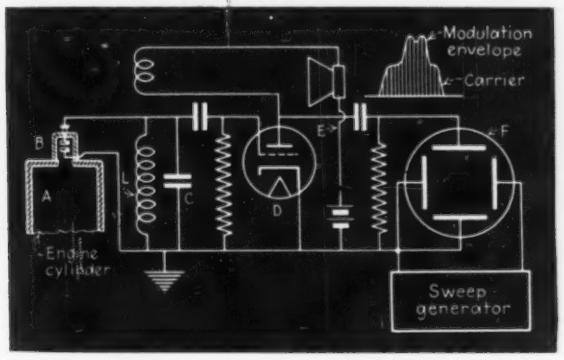


Fig. 8—Indication of gas-engine detonation characteristics

is applied from the plate of the oscillator tube to one pair of deflecting plates. A linear time-sweep generator which might be synchronized (not shown) by connection to the electrical circuit of the gas engine is connected to the other pair of deflecting plates. The closely spaced lines of the pattern on the screen represent the carrier frequency which shows the compression characteristics. The modulation on the carrier shows the fuel detonation characteristics.

SIZE-TOLERANCE indication is shown in Fig. 9. The material A passes under the gauge B, which is attached to one plate of a condenser. Fluctuations in the thickness of the material cause capacitance fluctuations which control the oscillation of the tube D, which are applied to the deflecting plates of the cathode-ray tube.

ELECTROCARDIOGRAPHS may use cathode-ray tubes as indicators. The input connections and amplifier are the same as usually employed with a galvanometer, except that an additional amplifier stage is used. This amplifier stage is connected to one pair of deflecting plates. A time-sweep voltage giving the beam a single slow sweep across the screen is obtained by charging the C_1 through R_5. The switch B_1 short-circuits C_1 initially through R_7. The initial positioning of the spot on one side of the screen is adjusted by the negative voltage applied with potentiometer R_1. When switch B_1 is opened, condenser C_1 charges negatively with respect to ground and causes the spot to sweep across the screen to the right. The sweep is linear with time, since a high-

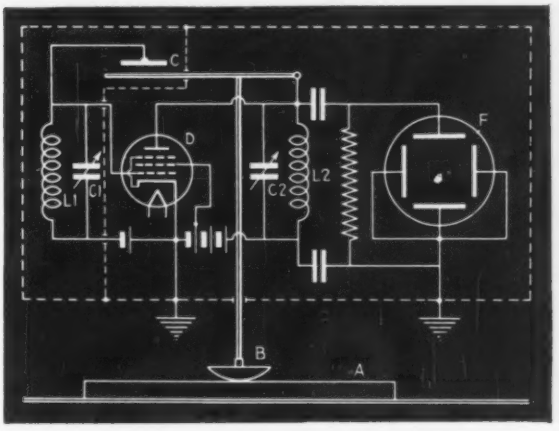


Fig. 9—Cathode-ray tube size-tolerance indicator

voltage source is used and the non-linear portion is off the screen. The speed of the sweep is controlled by R_5. Additional brilliance for photographing the pattern on the screen may be obtained by closing switch B_2 just long enough to record the pattern. Switch B_2 reduces the negative bias voltage on the control-electrode of the cathode-ray tube to a predetermined value, thus increasing the brilliancy of the pattern somewhat beyond the limits permissible for continuous operation.

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[3]Ryan, Harris J., "A Power Diagram Indicator for High Tension Circuits," *Proc. A. I. E. E.*, Vol. 30, p. 511 (April, 1911). "The Cathode Ray Alternating Current Wave Indicator," Trans. A. I. E. E., Vol. 20, p. 1417 (1903).

[4]George, R. H., "A New Type of Hot Cathode Oscillograph—Its Application to the Automatic Recording of Lightning and Switching Surges," *Journal A. I. E. E.*, Vol. 48, p. 534 (July, 1929).

[5]Lindvall, F. C., "A Glow Discharge Anemometer," *Elec. Eng.*, Vol. 53, p. 1069 (July, 1934)

[6]Rathbun, J. B., "You Can Hear Your Gasoline Talk," *Petroleum Age*, Vol. 23, p. 30 (December, 1929).

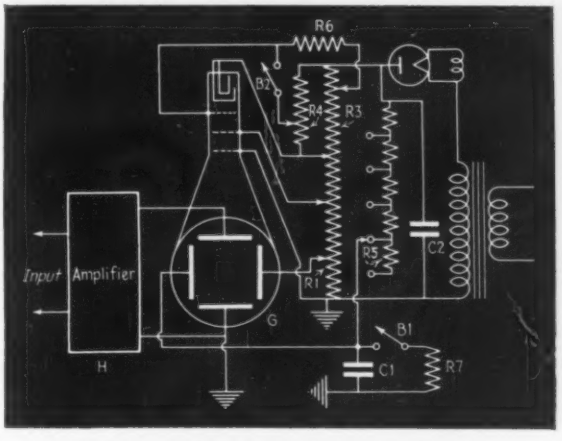


Fig 10—Cathode tube electrocardiograph

HIGH LIGHTS ON ELECTRONIC

New electric organ based on alternator principle

DERIVING the 91 harmonic tones of the musical scale from as many individual rotating alternators, a new electric organ of extremely wide range both in tonal color and volume has been developed by engineers of the Hammond Clock Company. The mechanism of the organ consists of a series of small rotating tone wheels, which are rotated in front of individual electro-magnets. The primary driving force is provided by a synchronous clock motor which fixes an unvarying fundamental pitch for the entire instrument. The rotation of the tone wheel near the electromagnet induces a harmonic sine-wave voltage in the winding of the magnet, the pitch of the note depending upon the number of revolutions per second and the shape of the tone wheel. From each of the 91 electromagnets, the corresponding electrical tones are transferred to individual attenuators and finally to a keyboard. The attenuators permit the introduction of nine different sub-harmonics and harmonics on each note, depending upon the position of each attenuator. By selecting the strength of these harmonic over-tones, relative to the fundamental, it is possible to produce an almost infinite variety of different tonal colors, covering the flute, diapason, strings and reed families, in addition to many tones which at present cannot be produced on the pipe organ.

The tonal output of each note is preamplified within the instrument and finally amplified to full volume in the power cabinet which contains the loud speaker. In addition to the harmonic controls, which are provided above the manual keyboards of the organ, there are nine pre-set keys which permit the organist to obtain changes in tone color, simply by pressing a key. The volume control or "swell pedal," which is nothing more than a wide range attenuator controlling the output to the loud speaker, has a dynamic range three times as great as that of the usual pipe organ.

The instrument is contained in an extremely small space, less than that occupied by a small grand piano. Because of the wide harmonic control permitted by the instrument, it is claimed that any type of sustained tone may be produced, regardless of the particular tone quality desired. The simplicity of the instrument permits it to be manufactured and sold at relatively low cost, less than that of a grand piano.

✦

New York restaurants get "music by wire"

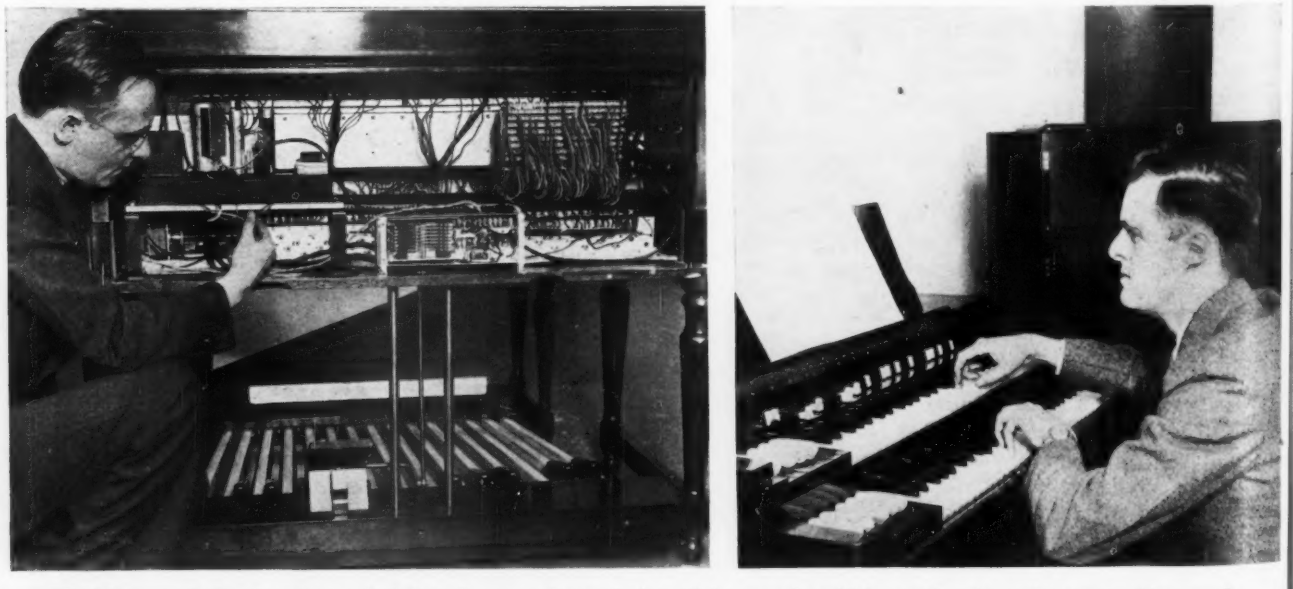
NEW YORK restaurants—about 20 of them so far—will continue to be served by music played by a single orchestra, and delivered over leased telephone wires to loud speakers. After two years of litigation, Wired Music, Inc., headquarters Hotel Holland, West Forty-second Street, has won the lawsuit instituted by the New York Telephone Co., and gained the right to use leased wires for its business. The telephone company is not interested any more—says it did not want to handle the "broadcasts" itself anyway, because it did not want to incur the displeasure of the musicians' unions, which object to the project on the ground that it throws more musicians out of work.

✦

Decoying geese with loudspeakers

TOBE DEUTSCHMANN of Canton, Mass., has an island off Cape Cod, to which he repairs to shoot geese. The island is small, and there is little room in the shack for the necessary live decoys. So Mr. Deutschmann bethought him of recordings of goose conversation, to be reproduced through loudspeakers. Two mated geese were separated and their chattering taken down on aluminum disks, each capable of playing 15 minutes.

Around the gunning stand on the island, four loudspeakers were installed in 4-ft. baffleboards, and screened with boughs. Control dials are in the hands of the man on watch, who in turn is warned by the actions of the live decoy birds on the beach. These decoys can hear or sense the approach of a flock of geese long before they can be seen by the keenest-eyed observer. As soon as the tame birds start chattering and the approaching flock of wild geese can be seen, the loudspeakers in that direction are turned on very loud. This sound, as of thousands of geese, invariably causes the flying birds to wheel around and come down into the wind, near the



The Hammond electric organ. At left is shown an internal view of the console, which contains the entire tone-making mechanism and pre-amplifier. At the right are the two manual keyboards. Just above the upper keyboard is the row of harmonic controls, by whose settings the quality of the tone is determined

DEVICES IN INDUSTRY + +

island. At this point all four loud-speakers are turned on at low volume, giving the impression of a great collection of chattering birds all over the island. The visiting geese then come closer to the shooting station, from which they can be killed.

This electrical decoy system has the advantage of saving in numbers of decoy birds, declares Mr. Deutschmann. Its difficulties involve the inconvenience of heavy batteries, and the tediousness of making good recordings of wild-life sounds.

✦

Flying-field lights photo-tube controlled

WHEN THE landing floodlights on a flying field are not themselves illuminated, they constitute a considerable hazard to planes attempting to use the field. It is important therefore that such floodlighting structures be marked with "obstruction lights" during all hours when natural illumination falls below a given level.

At the great Croyden Airdrome in England, photo-cell amplifier units are used to control these obstruction lights, so that the red marker lamps come on whenever darkness falls, or fog or clouds produce a bad condition of visibility during the daytime. In these Croyden installations, made by the General Electric Company of London, the amplifier circuit is so arranged that if the tube loses its emission or becomes defective in any other way, the lights controlled come on immediately.

✦

Testing headlights with photo-cells

TWO PHOTO-ELECTRIC CELLS furnish the "eyes" for a novel headlight testing board recently designed and placed into use by the Birmingham Electric Battery Company, Birmingham, Alabama.

The automobile headlights to be tested are placed in front of the board and the cells on the testing board adjusted to the same height from the floor as the headlights, and the same distance apart. The mounting on which the electric eyes are placed may be moved up and down as well as back and forth horizontally as desired by means of an electric motor with a two-way switch—which may be seen in the upper left hand corner of the board.

The photo-electric cells are connected with a dial (in the upper center of the board) which registers "bad," "fair," or "good," according to the intensity and focus of the lights.

The battery company makes a charge of 75 cents for testing out headlights, and where the lights prove poor has an opportunity to sell other such items as batteries, battery connections and light bulbs.

✦

Space detector locates concealed weapons

APPLICATION of space-radio principles to detect the presence of metal and magnetic objects and so to locate concealed weapons, is now being made at the Illinois State Prison at Joliet, Ill. This magnetic detector is used to "search" convicts and visitors alike as they pass through normal-looking but highly sensitive doorways.

Metals like iron, steel or nickel which have magnetic properties change the invisible but ever-present magnetic field of the concealed apparatus and ring a warning bell if present. Two installations are now being tested; one in a special doorway through which all visitors must pass and a second within a commonplace looking table on which all packages are laid.

First victim of the device was Thaddeus Johnson, negro trusty who "happened to have" a buttonhook within the lining of his jacket.

The Paul W. Koch Company of Chicago, who installed the device, point out other applications of the apparatus. Candy, for example, can be inspected at the factory for the rare possibility of a bit of metal inside a piece. Lawsuits resulting from people who claim to have broken teeth in this way may be headed off at the source.

Other uses, it is claimed, might include the device as a signal of the approach of an automobile at a filling station. Or an estate might be guarded by detecting a motor car coming up the private highway. Similarly the lighting system of a roadway sign could be controlled by the mechanism.

✦

Cigars wrapped with photo-tube's aid

BY ELIMINATING the usual bands on its cigars, and instead, wrapping the cigars in cellophane sheets, printed with an insignia, the Consolidated Cigar Corporation of Poughkeepsie, N. Y., has made a considerable saving. But the difficulty then arose of making sure that the insignia would come at the proper position when the cellophane was wrapped around the cigar.

In order to get the printing on each wrapper to line up precisely when on the cigar, photo-tubes were used, according to M. C. Boesch, master mechanic. Spots on the transparent wrapping control the cutting. Printed at definite intervals, they interrupt a beam of light trained on a photo-tube.

The electric impulse set up by this interruption is amplified by the vacuum tube system and operates the cutting knife through a relay.

Where plain cellophane is used in such wrapping, it does not matter if an error of, say, one one-thousandth of an inch in each cutting is made.

Adjustable photo cells measure the position and intensity of the auto headlight beams

A signal-synchronized sweep circuit

—for cathode-ray oscillography

IN some applications of the electron oscillograph it is desirable to use a sweep circuit which will syncronize without readjustment over a wide range of frequencies. The ability to synchronize in this manner is a feature of the circuit described below.

In Fig. 1, the control of the charging voltage is exercised at the point *A*. At this point, a type *27* tube is connected in series with the charging voltage. When this *27* tube conducts, the sweep condenser is charged; when the *27* is nonconducting, the sweep condenser discharges through the 58. The control of the *27* tube is provided by the two-tube amplifier which precedes it. The signal voltage applied this amplifier (which is the same signal voltage being viewed by the cathode ray tube) fixes number of times per second C_s is charged, and determines the period of the sweep voltage applied to the cathode ray tube. The connection BB prevents the signal voltage from exercising control once the discharge of the sweep condenser has begun, thus assuring a complete sweep cycle from maximum to minimum voltage without interruption. If the signal voltage changes frequency, the frequency of sweep changes in proportion, so that the sweep circuit is, in effect, self-synchronizing.

The following description of the circuit has been furnished by Professor C. E. Lansil, of the department of Electrical Engineering at M. I. T. who developed it.

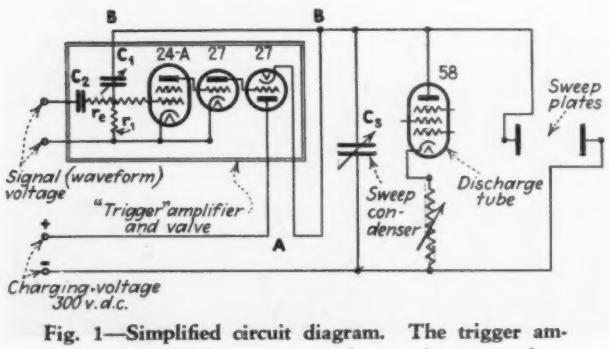


Fig. 1—Simplified circuit diagram. The trigger amplifier controls the sweep condenser charge synchronously with the signal under observation

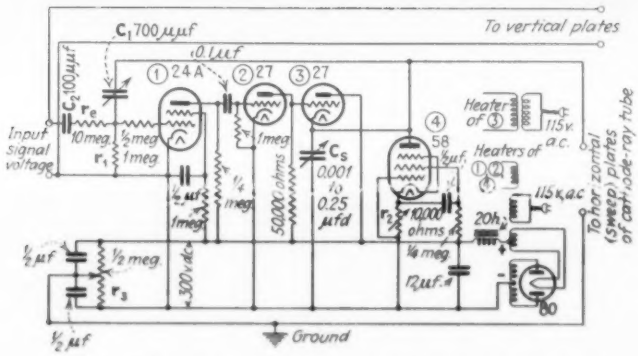


Fig. 2—Complete circuit diagram of sweep circuit for 115 volt a-c operation

In Fig. *2*. tubes 1 and *2* constitute a two-stage resistance-capacitance coupled amplifier, tube 3 is a valve tube and tube 4 is a regulator tube which draws a nearly constant plate current at all times. The action is as follows:

Assume that the charge on the sweep condenser, C_s, is the maximum that it can attain under the operating conditions and that the component of voltage e_1 (Fig. 3.) across r_1 due to the signal voltage applied at the input terminals, is on the positive half of the cycle. Under these conditions the grid voltage of tube 1 is positive, and the plate current large. The grid of tube *2* is at a negative bias sufficient to shut the plate current off completely. This negative bias results from the fact that during part of the cycle of operation the grid is positive, and rectification occurs. Tube 3 has its plate connected to the positive terminal of the plate supply. The grid of this tube is connected to the plate through the 50,000 ohm coupling resistance of tube 2. The tube drop is 10 to 20 volts, depending on the current drawn by tube 4, and determines the maximum charge which the sweep condenser can acquire.

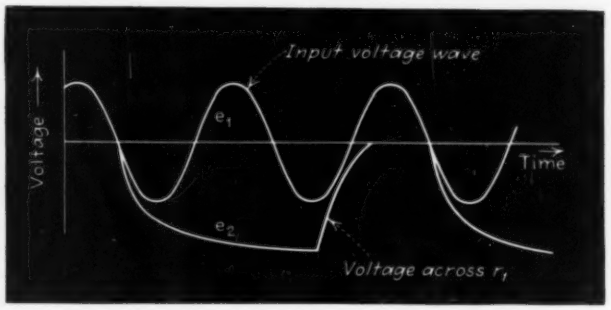


Fig. 3—Voltage relations which control sweep period

As the voltage component e_1 passes through zero, the plate current of tube 1 cuts off sharply which causes a large current to flow in the plate circuit of tube 2. This causes a high negative bias on tube 3, shutting it off. The sweep condenser C_s then begins to discharge through the regulator tube 4. As a result of the excellent regulator characteristics of the 58 tube, the rate of fall of potential across the condenser is linear within the precision of the oscillograph itself, provided the ratio of discharge current drawn by the deflecting plate circuit of the oscillograph is large.

As soon as the sweep condenser begins to discharge, the feed-back circuit causes a component of voltage e_2 (Fig. 3), to build up across r_1. If e_2 is sufficiently large

compared to the maximum value of the component e_1, the control voltage will not interrupt the sweep until the voltage across the sweep condenser has dropped to a value equal to the sum of the drop through the plate circuit of tube 2 and the grid bias necessary to keep tube 3 shut off. At this point the sweep stops suddenly and the charge on C_1 leaks off through r_1. When the voltage component e_2 reaches a value less than the maximum value of e_1, the bias on tube 1 will become positive on the next positive half cycle of e_1. This causes tube 1 to conduct, shutting off tube 2, and allowing the sweep condenser to recharge rapidly through tube 3, thus completing the cycle of operation.

This sweep circuit will synchronize with a varying frequency, and may be used satisfactorily in examining the wave form of speech or music. It will also operate on recurrent transient surges even though succeeding surges do not occur at equal time intervals. The recovery is not as fast, in general, as in sweep circuits employing gas tubes, but there is no limitation on operating frequency due to deionization time.

The sweep velocity is determined by the adjustment of the sweep condenser and the variable cathode resistor r_2 of tube 4. A certain amount of adjustment of the number of complete waves appearing, is made possible by varying the feed-back condenser C_1, but in general it is desirable to use the smallest permissible value of C_1, so that the charge on C_1 will leak off as quickly as possible at the end of the sweep. Delay at this part of the cycle will cause a "piling up" of waves at the end of the sweep. This delay, however, may be used to advantage in examining harmonics whose frequency is very high compared to the frequency of the fundamental. Since only one sweep can occur during each cycle, it is possible to increase the sweep velocity without increasing the sweep frequency, and a very small part of the wave may be enlarged to cover the entire screen without producing multiple traces. The particular portion appearing may be adjusted by using a Selsyn motor or other phase shifting device to supply the control voltage.

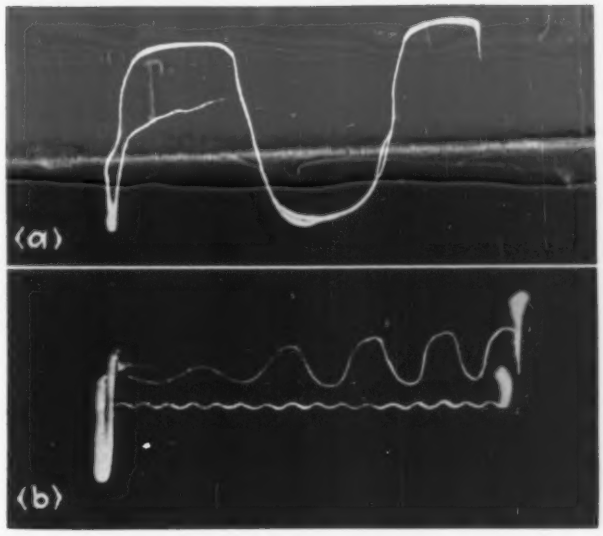


Fig. 4—Overloaded amplifier output viewed with signal synchronized circuit, (b) is a magnified portion of (a), showing harmonic content of wave. The timing wave in (b) is 25,000 cps

An illustration of this application is shown in Fig. 4. The wave form of the output voltage of a push-pull amplifier having a tendency to oscillate is shown in Fig. 4-a. The amplifier is badly overloaded and produces an oscillation having a frequency of about 8,000 cycles. Fig. 4-b is a portion of this wave enlarged to a point where the nonsinusoidal nature of the harmonic becomes obvious. The lower curve on Fig. 4-b is a 25,000 cycle timing wave.

WLW's "blind spot" antenna

[*Continued from page 152*]

be hoisted into place with rope tackle, and the steelworkers could not touch the steel pieces until representatives of the radio engineering department had first thrown flexible wires over the new steel pieces as hoisted, in this way grounding them.

Operation of the array

The antenna array consists of the main vertical radiator (831 feet high) and two symmetrically placed suppressor towers (each 326 feet high). The two quarter-wave suppressor towers are separated by a distance of a half-wave length, and are phased together, so that the radiation pattern they produce is a "figure eight," with its long axis pointing in the direction of Toronto. The base line between these two towers lies 1850 feet behind the main radiator, giving a space phase of 474°. The current in the suppressors lags the current in the main radiator by a time-phase of 96°.

This arrangement results in destructive interference between the waves radiated by the main antenna and those radiated by the suppressor towers, but this interference is confined to one direction, that pointing toward Toronto. In addition the maximum interference occurs at an angle of 20° above the horizon, so that in effect the radiation is greatly reduced within a comparatively narrow "cone" pointed 20° into the air in the direction of Toronto. When reflected by the Heaviside layer, this cone of reduced signal strength falls on the area surrounding Toronto, so that the interference produced in that area is reduced to the same value as existed before WLW increased power from 50 to 500 kw. The design of this unique system, which proceeded under the direction of J. A. Chambers, Chief Engineer, is largely the product of G. F. Leydorf, Radiation Engineer, and J. E. Whitehouse, Chief Transmitter Engineer, of the WLW staff.

Field strength measurements, conducted by WLW engineers within the affected area, have indicated that the entire system is working as planned. During these tests, which were conducted during the early morning hours, a regular schedule was set up. For fifteen minutes, the transmitter was operated at 500 kw power with the suppressor towers radiating. During the succeeding fifteen minutes, the station was operated with only 50 kw output, but with the suppressors disconnected. Theoretically, both types of transmission would produce equivalent signal strengths in the area surrounding Toronto; actual tests showed that such was the case, within the experimental error. Similar measurements conducted by the Federal Communications Commission are now being compared with those made by the WLW staff. With the success of the system demonstrated it is expected that WLW will resume full-time operation on 500 kw sometime this month.

+ + NOTES ON ELECTRON

Millionths of an inch measured with an electronic relay

METALLURGICAL research sponsored by John Chatillon & Sons, manufacturers of weighing devices, developed a new spring material of the elinvar type having a negligible change in elasticity with temperature. Spring tests also showed this material to have small hysteresis or elastic lag; that is, a steady load applied continuously resulted in little increase in deflection of the spring even after an extended time.

Because of the small amount of elastic lag, usual methods of measuring the effect lacked sufficient sensitivity and an electronic micrometer developed by R. W. Carson, assistant Editor of *Product Engineering* was called into play to make these measurements.

Since the total amount of hysteresis found in these tests was less than 0.08 per cent of the spring deflection, much less than for the usual spring materials, it was necessary to increase the sentitivity of the micrometer. By the use of a new electronic relay developed by the Westinghouse Electric & Mfg. Co., point of contact between micrometer and test piece was indicated with a series resistance in the micrometer contact circuit of more than 30 megohms. This increased sensitivity made possible direct measurements of deflections as small as five one-millionths of an inch, giving an accurate determination of the small elastic lag.

Applications of graphite in tube manufacture

GRAPHITE FILMS formed on solids with the aid of concentrated dispersions of colloidal graphite in water, are steadily finding new applications in the electronic field. The adaptability of such films to resistance elements and as ray focusing anodes in cathode-ray tubes are well known applications of this material.

The use of graphite films with other electronic devices as shields against glass charging and extraneous high frequency disturbances is a common application. Frequently during experimental work with amplifiers and mercury vapor tubes extraneous fields, due to nearby induction coils or similar apparatus, must be reduced and electric charges collecting on the glass from internal tube operation must be prevented. A solution to these immediate and oftentimes troublesome problems is an application of Acheson's "Aquadag."

To obtain coatings of this kind the glass envelope should first be cleaned with any oxidizing agent like chromic acid, then carefully rinsed, and later dried in warm air. A single coating of fairly concentrated colloidal graphite solution can then be applied by means of a soft camel-hair brush. In order not to cut down appreciably on the heat radiation from the internal electrode structure, this exterior coating might cover only three-fourths of the tube or be applied with latticed-effect strokes. By fixing a loop of wire or strip of metal about the tube before applying the coating, a good permanent grounding connection can easily be made.

An additional application of the graphite film is the formation of guard rings on photo cells, evacuated systems, and in other instances where metal rings were used. The facility of applying a graphite ring and its permanent adhesive properties for glass, porcelain, bakelite and enamel, make it in many cases preferable to metal strips. For each of these suggested uses the dark and homogeneous layers of graphite, with their non-reflective, chemically inert, and electrically conductive properties are outstanding.

✦

Paper vs. electrolytic filter condensers

A DISCUSSION by engineers of the Aerovox Corporation, in the Aerovox Research Worker, discloses the fact that a 20 per cent power factor in a filter condenser results in only 2 per cent loss in filtering efficiency, under ordinary conditions. In a three-condenser filter of the ordinary type used in radio receivers, the total increase in hum caused by 20 per cent power factor in all those condensers is only 6 per cent.

This result, which was arrived at by Mathematical analysis, is offered as evidence against the commonly held view that a 4 or 5 microfarad paper condenser has the same filter efficiency as an 8 microfarad electrolytic condenser. Most electrolytic condensers have power factors under 20 per cent, and the better made types have power factors of 10 per cent or less. The calculations, which were made on the basis of the 120-cycle current, provided by a full wave rectifier, show that the use of electrolytic condensers results in a loss of filtering of only 6 per cent, as compared with the filtering provided by paper condensers of equivalent value.

✦

Laboratory for commercial color analysis

ALTHOUGH photoelectric measurements of color have been known for some time and although there is rather general agreement that the spectrophotometric method of color analysis is the only fundamental method, individuals and companies hesitate to make the neces-

ALL-WAVE SERVICE AT WALDORF-ASTORIA HOTEL

View of the radio program distribution equipment of the Waldorf-Astoria Hotel in New York. Among the six program choices provided for guests are several European shortwave programs

sary investment in apparatus and personnel to enable them to make use of these modern analysis tools. There is another group which would not have enough work to keep such apparatus or personnel busy and therefore could not justify the investment.

To aid these two groups the Razek Development Laboratories have been formed by Dr. Joseph Razek, co-inventor of the Razek-Mulder photoelectric color analyzer (see *Electronics*, May, 1933, p. 128). This laboratory at 430 Greenview Lane, Llanerch, Pennsylvania, will have complete equipment for such measurements as well as the necessary technical personnel to enable industry to take advantage of the photoelectric methods of analyzing color.

✦

Flux balancer for output transformer

By Earl R. Meissner

In a single ended amplifier the d-c component of flux in the output transformer is often bothersome. Of course the tube can be parallel fed but this adds the weight and cost of a choke coil.

Another method of reducing the d-c flux has been to pass a relatively high current through a third winding on the transformer as is shown in Fig. 1. The turns and currents are so proportioned that the ampere turns of one winding equals the ampere turns of the bucking

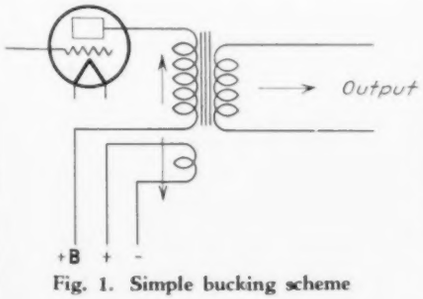


Fig. 1. Simple bucking scheme

winding. If i_2 is large in comparison to i_1 and n_2 small then the impedance coupled into circuit 1 from circuit 2 is several times higher than the load impedance and thus circuit 2 absorbs practically no power. On the other hand if the two windings have equal turns and, therefore, equal currents one finds that the tube is working into an impedance somewhat less than the impedance of the tube, whereas it should be working into an impedance of about twice its plate impedance. Thus this

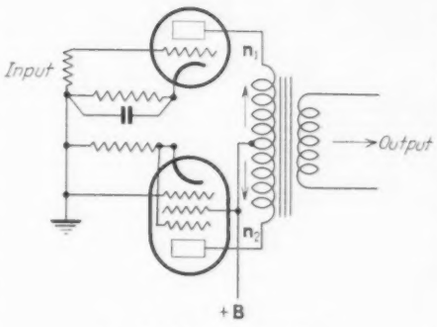


Fig. 2. Use of a pentode

method is only used where the power source is such that i_2 can be made large and n_2 small. It has been used considerably in d-c operated condenser microphone pre-amplifiers, the current i_2 being supplied from the "A" battery.

Another method of flux bucking, which is adaptable to a-c amplifiers, makes use of a pentode tube. The circuit is shown in Fig. 2. The output transformer is designed so that the load impedance presents the correct load to the output tube. The windings n_1 and n_2 can be made equal and the bias adjusted on the pentode so that the plate currents are equal. This will fulfill the condition for flux balance in the output transformer.

In an actual case an 89 was used as a triode for the output tube, another 89 as a pentode for the balancer. With Ep = 135 volts, i_1 = 20 ma. i_2 = 20 ma. Load resistance for triode, 6,500 ohms. Plate resistance for pentode 92,500 ohms. Now let n_1 equal n_2. Thus the resistance of the pentode transferred to circuit 1 is 92,500 ohms. This high resistance in parallel with the load resistance of 6,500 ohms is negligible and thus absorbs practically no power.

This method of flux balancing is not limited to the use of a triode as the output tube. A pentode can be used just as well and in fact is somewhat simpler because for equal plate voltage and equal bias the tubes will be balanced. Figure 3 shows a pair of 41's used in this way. Here the plate currents are 12.4 ma. each and the plate resistance 94,000 ohms while the correct load resistance is 10,400 ohms. Thus the balancer tube throws 94,000 ohms in parallel with the load resistance of 10,400 ohms which again is negligible.

Figure 4 shows results of an experimental set up. Using a 41 tube with no bucking current in the output transformer, curve B was obtained. Using another 41 pentode tube to supply bucking current, curve A results. Note that the maximum gain remains the same. This proves that the pentode balancing tube offers practically no load to the output tube.

Curve C was taken using a resistance in place of the balancing tube.

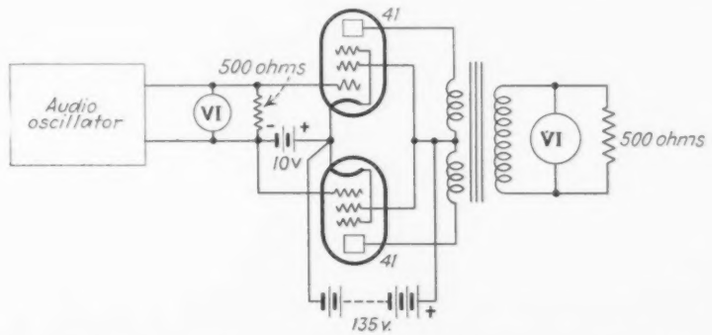


Fig. 3. Two 41's in circuit used for obtaining curves of Fig. 4

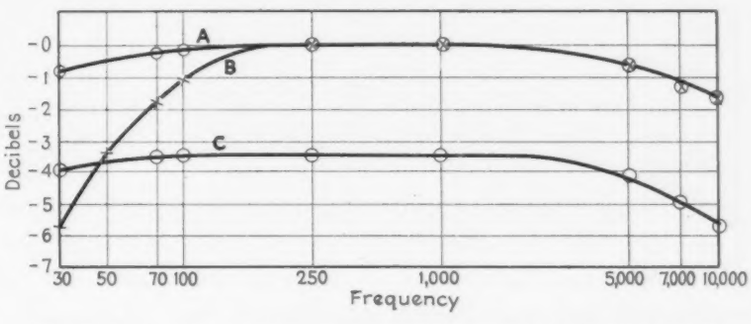


Fig. 4. Improvement in frequency response provided by bucking circuit

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

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Vol. VIII —MAY 1935— Number 5

The IRE to convene at Detroit July 1, 2, 3

THIS year the annual convention of the Institute of Radio Engineers goes again to the Mid-West—to Detroit, July 1, 2, and 3. This meeting of the Institute in the Central section of the country calls attention to the fact that the IRE is a really national body, and draws its members from all parts of the United States. Although for convenience of board meetings, the directors are chiefly residents of the East, in the vicinity of New York, care is taken to preserve the national aspect of the organization, and frequent conventions in cities of the Middle West are evidences of this continuing policy.

The Detroit convention is also recognition of the radio engineer's keen interest in automobile radio. As the automobile manufacturing center of the world, Detroit will have plenty of interest to show to visiting radio engineers. The prospect now is that the coming meeting at Detroit will prove one of the most important gatherings ever held by the Institute.

Major Armstrong fights static

EXPERIMENTERS hearing strange noises on the high-frequency carrier emanating from the television station atop the Empire State building wondered what manner of gibberish the NBC engineers were pouring into the ether. Late in April the news came out—Major Armstrong of superheterodyne, oscillation, super-regenerator fame, has been fighting static with an old-new weapon, frequency modulation.

By the use of current limiting devices and the method of modulation in which the bandwidth varies as the amplitude of the modulation, Major Armstrong seems to have solved the missing link in the battle against man-made and natural static. "So long as the static and the signal are of the same order of magnitude, a reduction of 1,000 to 1 in the energy of the static is accomplished." So states the inventor.

The advantages of such noise reduction to communication whether for code, for voice, for music, or for pictures are more than obvious. On all bands, including broadcast, a reduction in noise is equivalent to an increase in power. All the radio world awaits a description of Major Armstrong's work—a review of which will appear in the June issue of *Electronics*.

Public hazards in radio?

WHAT legal justification is there for registering *radio* engineers under the new state license laws, many radio men have asked.

Where radio men deal with apparatus which has some hazard to the public, the prime cause of "public safety" is involved, and so the protection of the public interest may involve inquiry into the technical qualifications of the radio engineer. The fire risk(?) in radio receiving sets is one situation of this kind, it might be conceived—and so the public interest might require that the design and construction of receivers offered the public, be supervised by a qualified chief engineer. Similar considerations are involved in the erection of radio towers and other radio structures, the collapse of which might work personal injury to members of the public—although here the argument seems rather slender if the erection of the structure is performed by a qualified construction engineer.

Already about 45,000 engineers of all kinds are registered under the licensing laws of the 28 states having such laws. Included in this total are the registrations for the larger states: New York, 12,000; California, 8,000; and Pennsylvania, 4,000.

Hundreds of millions to spend

THE Federal Government is now spending four billion dollars, and much of this will go out through channels that involve engineering design and engineering administration. Engineers of the older groups will benefit greatly. Here is the way the four billions are to be spent:

Highways, roads, grade-crossings	$800,000,000
Rural conservation, irrigation..	500,000,000
Farm-line electrification	100,000,000
Housing	450,000,000
Aid for professional educational groups	300,000,000
Civilian conservation corps.....	600,000,000
Loans, grants to states, cities, etc.	900,000,000
Sanitation, reforestation, flood control	350,000,000
	$4,000,000,000

Radio men who last Fall investigated the costs of a nation-wide television set-up using short-wave relay stations, reported that an outlay of $100,000,000 to $250,000,000 would be required to cover the continental United States. Of course this figure may all be changed by the new development in co-axial conductors, capable of transmitting one or more million cycles with ease. Such a wire television network might cost much less.

But in comparison with the Federal outlays indicated above, the application of radio-television men for a few hundred millions—to create new "highways in the ether," and make the miracle of television come to pass—now seems a modest request indeed.

NEWS NOTES

Conventions Ahead—

Society of Motion Picture Engineers, Hollywood, Cal., May 20 to 24.

American Institute of Electrical Engineers, Ithaca, N. Y., June 24-28.

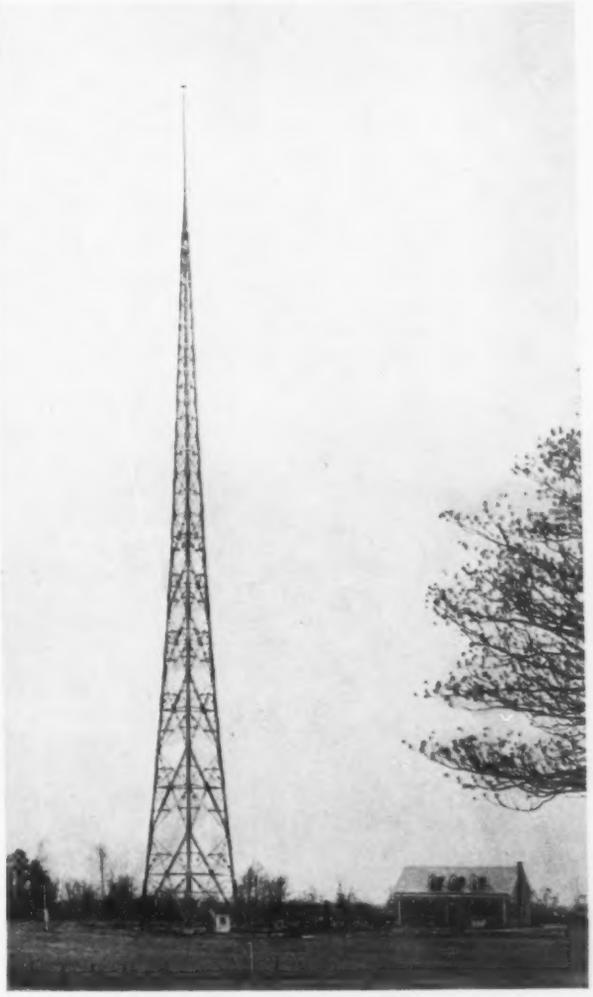
Institute of Radio Engineers, Hotel Statler, Detroit, Mich., July 1, 2, 3.

Television interest in France—Following in the wake of Germany and England, interest in television in France is becoming acute, particularly since an announcement by the French Government that an official television broadcast transmitter is being made ready for operation on the Eiffel Tower in Paris.

First all-wood broadcasting tower at Richmond, Va.—Radio station WRVA's new triangular all-wood tower 320 ft. high, just completed at Mechanicsville near Richmond, replaces two steel towers, and is expected to increase the 5000-watt transmitted signal. The three feet of the tripod rest on 12-ft. squares of concrete, each weighing 36 tons. The tripod construction is designed to reduce wind resistance and to withstand wind velocities of 100 miles per hour. Paul F. Godley, Upper Montclair, N. J., was consulting engineer. This is the first such all-wood tower to be eretced in America, although in Germany wood towers have reached heights of 625 ft.

Industrial Electronic Tube Section, NEMA—The National Electrical Manufacturers Association has just issued the following re-definition of the scope covered by its new industrial electronic tube group: "Vacuum and gas-filled electronic tubes, and light sensitive devices having functions similar to such tubes (such as photo voltaic cells) for non radio applications and other uses of electronic tubes for other than radio purposes; electronic tubes for industrial uses *including tubes used in cauterdyne and diathermy sets.* Exceptions, tubes used in radio receivers, transmitters, wire communications, sound and/or picture recording or reproduction, or television; sunlamps, x-rays, vapor lamps, and electronic devices used as a light source; bulbs of the tungsten argon type having a maximum d.c. rating of 120 volts."

WRVA's 320-ft. ALL WOOD TOWER



This triangular structure at Richmond, Va., employs clamp-connectors to utilize the full cross-section of the timbers, which are of long-leaf heart Southern pine. The three bases stand 38 ft. apart

A REVIEW OF THE ELECTRONIC ART HERE AND ABROAD

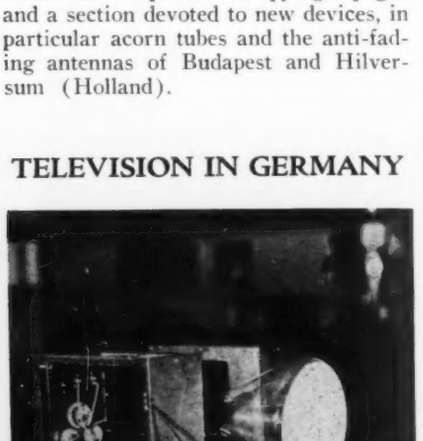
Radio journals of Italy

WITH the beginning of its fourth volume, the Italian technical radio bimonthly — *Alta Frequenza,* published with the aid of the Italian Research Council (G. Marconi, President), the Italian Electrochemical Association and the Physical Society, has made improvements in the printing of its notes and reviews. Moreover, members of the Italian Electrochemical Association may now at their option receive *"Electrotecnia"* or *"Alta Frequenza."*

The first 1934 number contains three articles of about 20 pages each, as follows: *M. Boella:* Measurement of condenser losses at high radio frequencies (see these Digests); *N. Carrara:* The magnetron as a negative resistance; *C. Borsarelli:* Production of radio receivers in the United States. The latter is a review of the developments which have taken place in the past ten years and insisting on the part which the laboratory plays in all the factories.

The second part contains 16 pages of extended abstracts, mainly from the German literature (*H. F. Technik; El. Ak.*); 8 pages of shorter abstracts; a review of five patents occupying 9 pages and a section devoted to new devices, in particular acorn tubes and the anti-fading antennas of Budapest and Hilversum (Holland).

TELEVISION IN GERMANY

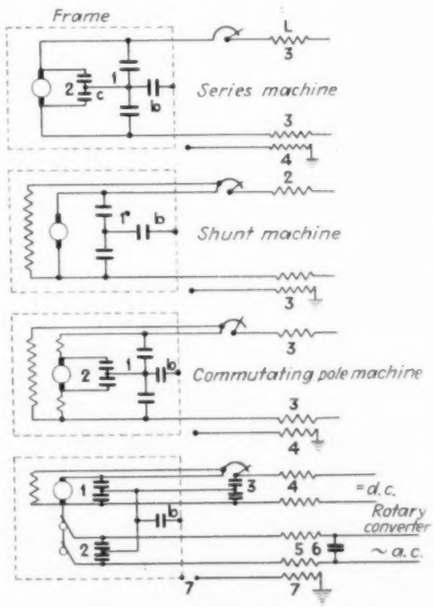


Neat construction of Telefunken's new television receiver

France fights man-made statics

[P. DAVID, chief engineer, National Radio Laboratory.] Artificial static most often represents free oscillations set up in circuits near apparatus in which rapid current changes take place, or in which the current is interrupted or reversed, or that in which the contact resistance varies. They are propagated across free space, the intensity falling first with the inverse square of the distance and farther away inversely as the distance; they are also carried along transmission lines, where they form two components, one symmetrical, that is the two lines carry equal current, but of opposite signs, and an asymmetrical component which runs along both wires in the same direction and returns via the ground. Opinions differ as to whether these two components are of the same magnitude. It seems quite possible that the asymmetrical component is a greater nuisance. If the lead-in wire of an antenna runs along the wall, it is influenced by a-c lines and readily picks up the entire asymmetrical component, whereas the symmetrical components neutralize one another to a certain extent.

To suppress the radio noises at the source it is sometimes possible to change the circuit constants by increasing the damping, in the case of induction coils by adding resistors or discharge tubes in series, or by increasing the capacity. To prevent radiation by leads and lines, the wires must be twisted or symmetrically placed with their center grounded, or put under a screen. For convenience, metal gauze is used for screening. In a completely closed cage of copper gauze with 1.5 mm. mesh, the intensity of a 450 meter wave is found to be reduced by 54 db. When the mesh is coarser (1.8 cm.) and of iron, two walls of gauze spaced 8 cm. apart, reduce the intensity by about 35 db. For preventing the propagation of static along a power circuit, series inductances and shunting condensers are added. To affect both components it is necessary to add a by-pass to the ground. Practical information on r-f chokes is rather meager although formulas are available for computing the effect of the shield. An impedance of 30,000 ohms without can and 15,000 with the can when strong currents are involved is of little use. Commercial elimination of man-made static often consists of anti-resonant circuits. In the case of flashing signs and similar interruptions, the reduction is perhaps 100:1, and therefore far from complete. Motors without collectors seem to be silent; on the other hand it is quite certain that a motor with strong sparks at the brushes may cause less static than a motor presenting apparently no sparks. A report by the French Producers' Union indicates that for machines above 2 kw.



Circuits for suppressing rotating-machine noise

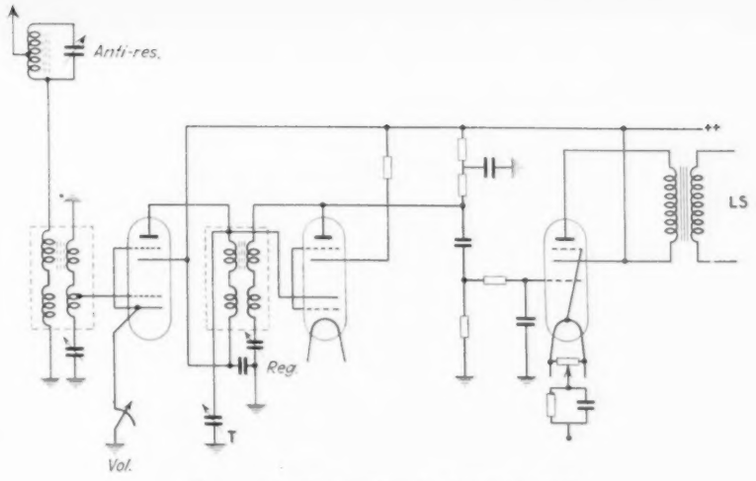
the results obtained with filters become uncertain. According to French experience it is also nearly impossible to silence elevators, which may produce 675 millivolts per meter.

Onde el. 14 (*No.* 158): 69—85. 1935.

✦

Radio receivers at the Leipzig Fair

[E. SCHWANDT a.o.] In contrast with other years the 1934 German Industrial and Building Fair in Leipzig shows a large number of new radio receivers, one reason being that by agreement no new set designs are to be offered between February 1 and August 1, 1935. The news that several of the larger firms were going back to the three-tube set with two tuned circuits in place of the cheaper two-tube reflex sets has induced other firms at the last minute to complete their list of products. The 15 firms exhibiting radio receivers at the fair offer eight new one- or two-tube sets with a single tuned circuit, ten new sets with two tuned circuits, two three-



German 3-tube receiver in favor in 1935

circuit sets, three three-tube superhets, five four-tube and two five-tube superhets. A feature appearing for the first time is the tendency to consider the receiver no longer as a product changing from year to year and from firm to firm, but as an instrument approaching its standard design, and remaining for years in the hands of the customers. Among the two-circuit sets is one with a three watt output pentode which allows two loudspeakers to be used, and a battery set with class B giving two watts. By using r-f coils with iron dust cores high selectivity and great daytime strength are obtained.

In the typical three-tube set such as it is manufactured by the German G. E., for instance, the signal picked up by the antenna passes over an anti-resonant circuit, which rejects the local sender, and a first variable band filter to the grid of the first exponential r-f pentode, which has a screened variable filter in its plate circuit. This second filter is connected to the grid of the next pentode which acts as regenerative detector with the same amount of reaction for all waves; it is resistance-capacitance coupled to the output pentode. Since pentodes have much higher amplification factors than screen grid tubes, with about the same plate current versus grid voltage slope, they possess a much higher internal resistance, making necessary the use of sharply tuned filters with an impedance of about ½ meg., their construction being rendered possible by the use of iron-core coils. The price of a set of this type is about 200 German marks. Its construction proves that the more expensive superhet is not indispensable for securing selectivity, on the other hand it has not been found practical to add the short wave range to this set. There are no less than eight new sets of this class against one in the past year, in which ten new two-tube reflex sets took their place.

Among the accessories, loudspeakers are prominent; there is an electrodynamic speaker reproducing only the frequencies between 3,000 and 10,000, its coil setting a thin metal film in motion. A giant loudspeaker makes use of a permanent magnet capable of carrying two group-up persons.—*F. tech. Mon.* 3 (No. 3): 97-99. 1935. *El. tech. Z.* 56 (12). 1935.

✦

Interference reduction in Great Britain

[J. NEALE, General Post Office.] A detailed discussion of artificial static has recently taken place before the London Technical Group of the Electrical Power Engineers' Association. The British Post Office Department which handles about 40,000 complaints each year has standardized on six inductances rated to carry 3, 5, 15, 25, 50 and 100 A. with a distributed capacity producing resonance in the broadcast band; the impedance reaches a peak of about 100,000 ohms at 1,100 kc. for the second coil. Two sizes of earthed metal cases for enclosing the coils are available. The capacity of the condensers used is 2 μf. in most cases; but the inductance of the connecting leads in series with the condensers is not negligible, as a rule, the combination tending to give minimum impedance in the middle broadcast range and representing a fairly high a-c resistance at higher frequencies. The inductance per foot of wires spaced one inch apart is about 0.5 microhenry, and when long leads are found necessary, smaller condensers should be used. It is intended to standardize 0.25 and 0.1 μf. condensers for this purpose. The filters now employed are useless at very short wave-lengths.

In the case of disturbances caused by a multiple contact flashing sign or the like, all that can be done in general is to prevent their being conducted into the supply lines by providing an electrostatic screen and r-f filter. The screen comprises a metal container for the flashing mechanism and steel-conduit or lead-covered wiring from the flashers to the lamps. In the case of an electric motor, the metal frame of the machine in practice is a complete electrostatic screen, and in view of the series impedance in the armature windings, a condenser filter is often sufficient. Exposed metal pieces on portable appliances, such as sewing machines, hair dryers, refrigerators, fans

FIVE-METER RADIO FOR BRITISH FIRE DEPARTMENT

Capt. Beckett of the Northwood, England, fire brigade can talk back to headquarters from any point in the 20 sq. miles his brigade protects

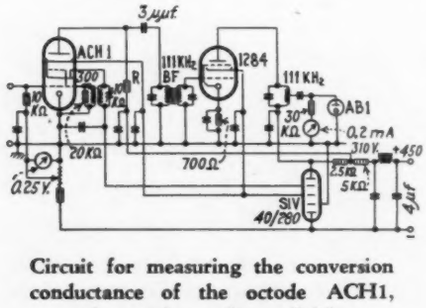
are not earthed, despite the recommendations by the I. E. E. to this effect, and it is necessary to insert condensers between the supply leads and the metal case of the machine. In this case the capacitance shall not exceed 0.01 μf. in order to reduce the current to 1 ma. in case of a person accidentally completing the circuit to earth. It is sometimes found that grounding the appliance renders interference more serious. A good practice is to insert a low resistance choke coil into the earth wire, thus unearthing the frame, but keeping it earthed so far as safety is concerned.

The most recent method of silencing radio noise caused by street cars is to connect condensers from the overhead line to earth at intervals of 60 or 70 yards. Trials by the Electrical Research Association have encouraged the Southend-on-Sea Transportation Department to introduce the system on one of its lines. During the past three years r-f choke coils have been mounted with good results on the roof and inserted in the leads from the overhead collector, the coils consisting simply of copper strip round into a spiral with asbestos insulation.—*Electrician 114.* (No. 2957/58): 151-152. 179-181. 1935.

✦

Conversion conductance in frequency-changer tubes

[K. Steimel, Telefunken Laboratory.] Amplification in frequency changing tubes, whether pentodes, hexodes or octodes, is best defined in the same way as it is in r-f tubes, namely as the ratio of plate voltage change to grid voltage change, although in the present case two different frequencies are involved, and the conversion conductance is the ratio of the plate current change (at the intermediate frequency) to the



Circuit for measuring the conversion conductance of the octode ACH1, using a glow voltage divider

grid voltage change (at the incoming signal frequency). Frequency changing is essentially a modulation in the tube made possible by the curvature of the characteristic, the signal being modulated by the voltage of the local oscillator and causing cyclic changes in the mutual conductance between plate and signal grid, this in the rhythm of the oscillator wave. The intermediate frequency represents one side band of the process of modulation. In the simplest case the conversion conductance G of the tube is proportional to the oscillator voltage. The best grid bias must then be decided upon, in order to make full use of the tube without overloading it. For a pentode, assuming uniform curvature, it is the point at which the mutual conductance is one-half the maximum conductance obtained during one cycle of modulation, or of the highest mutual conductance at which the tube can be operated under normal conditions. For the four-grid tube the bias of the oscillator grid should be so chosen that the mutual conductance with respect to the first or signal grid is about one-half the mutual conductance which the oscillator grid possesses during the positive half of the wave. When the mutual conductance at the operating point is called G_{av}, the formula representing modulation gives for the plate current (with M as the degree of modulation):

$$I_p = AG_{av}\,(1 + M \sin Lt) \sin r\,t,$$

where A is the amplitude of the signal of pulsation r, and L the pulsation of the local oscillator. By using trigonometric formulas the current at the intermediate frequency is

$$I_n = 1/2\ AG_{av}\,M \sin nt$$

and, therefore, the conversion conductance as defined:

$$G = I_n/A \sin nt = MG_{av}/2$$

or equal to $Mg/4$ when g is the maximum mutual conductance of the tube.

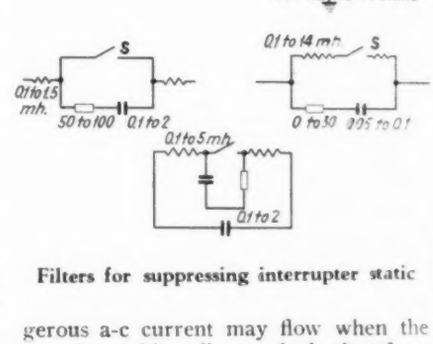
When the amplitude of the local oscillator is such that the characteristic can no longer be considered linear with respect to the oscillator, higher powers of sin Lt with different amplitudes, a, b, c, enter into the formula for the plate current; when they are reduced to functions of L or its overtones, the odd-number harmonics increase the value of G. For pentodes the result to be expected can be deduced from the three-halves power law involving grid bias and screen voltage. For four-grid tubes the symmetrical curve representing plate current against signal grid change as a function of the oscillator or grid bias may be used or the development in powers of sin Lt and cos Lt. This gives $G_{av}:G = 1.57:1$.

Measuring the conversion conductance is relatively simple owing to the high internal resistance (over one megohm) of the tubes used, making the amplification equal to GR, where R is the load. The load R need not exceed 10,000 ohms. A known ratio frequency in place of the signal is applied to the first grid of the tube and a bandfilter BF tuned to the intermediate frequency is inserted into the output circuit. The volage is amplified and then measured with a duo-diode. The input voltage is adjusted until a known output is obtained as shown in the figure.—*Telefunken-rohre* 1. No. 3: 85-94, 1935.

German electrical engineers noise campaign

The recommendations are intended as a guide in the fight against interference and will become more or less binding when the new law regarding artificial static enters into force. For this purpose, going methodically from simple to more complicated cases, the electrical devices are grouped as follows: Generators, motors, and transformers; switching devices; signaling and telecommunication plant; rectifiers; high frequency and finally diathermal medical appliances. The means by which interference is lessened are (a) condensers, (b) condensers with resistors, (c) coils, (d) coils with condensers, (e) screens.

The size of the condensers used between phases is not limited unless one terminal is connected with the frame of the machine; in this latter case a dan-



Filters for suppressing interrupter static

gerous a-c current may flow when the case is accidentally touched, therefore, the frame of a machine is not grounded or not connected to the neutral, and a condenser, the so-called condenser contact (b) is added to the machine while it is still in the factory, then the current flowing from the frame to ground shall not exceed 0.4 ma.; when the condensed is added later on, the current shall not exceed 0.8 ma. When the frame of stationary machines is grounded, the current in the wire connecting the condenser to the frame shall not exceed 3.5 ma.; for mobile machines with a grounded frame the current shall not be more than 0.4 for factory-equipped samples and 0.8 ma. for older machines. If more capacitance is required for silencing the noise, the current shall in no case exceed 3.5 ma. When the frame is connected to a grounded neutral which carries current no limit is set and no condenser is required between neutral and frame. The components of the filter shall be added in the succession indicated in the illustrations. The coils used have between 0.1 and 5 mh., the condensers between 0.1 and 2 μf.

Rules are also given for the other cases mentioned.—*El. tech. Z.* 56 (No. 11): 332-333. 1935.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Socket for 955 acorn tube

A LOW-LOSS socket for the 955 acorn tube has been announced by the Alden Products Company, 715 Center Street, Brockton, Massachusetts. This socket, which has been especially designed for use at ultra-high frequencies, is provided with special insulating material, Na-Ald Victron, to insulate the grid and plate terminals of the socket. The base proper is molded of bakelite, and has the form of five stand-off posts, at the top of which are special phosphor bronze clips which grip the projecting connecting wires of the tubes. The terminals for the two heater leads and the cathode are mounted on the top of bakelite posts, while the terminals for the grid and plate are mounted on Victron. This material has a lower loss factor than fused quartz (at 100 kc.), according to the manufacturers. A special stand-off post is provided so that it is impossible to place the tube incorrectly in the socket. The socket may be used to accommodate the new 954 acorn pentode, if the tube is placed in the socket upside down. A specially designed socket for the pentode is now in process of manufacture and will be announced shortly. The list price of the No. 4955V acorn tube socket is $1.50.—*Electronics.*

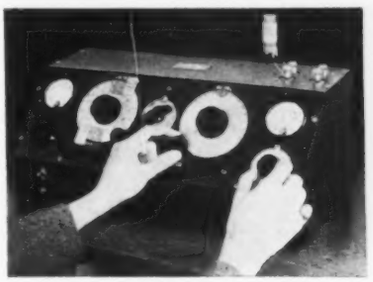
✦

"Wedge-on" conductor terminal

THE THOMAS & BETTS Co., Elizabeth, New Jersey, has recently developed and put on the market a new mechanical lug which has been given the name "Wedge-on Conductor Terminal." The installation of the "Wedge-on" merely consists in exerting a tremendous mechanical pressure on the wire by forcing the tapered wedge into the barrel by means of a specially constructed tool which stocking jobbers are giving away with orders for 200 "Wedge-ons." Just enough insulation is cut off the cable so that when it is introduced into the lug the bare wire is within the whole length of the tapered wedge and the insulation is supported by the barrel. The speed and simplicity of the operation naturally results in reduced costs and also eliminates objectionable features of soldering. "Wedge-on" conductor terminals are used with wire ranging from sizes Number 22 to Number 4.—*Electronics.*

Q-meter

A METER for the direct measurement of Q (ratio of reactance to resistance), known as The Q-Meter, has been introduced by the Boonton Radio Corporation, Boonton, New Jersey. The meter is designed to operate throughout the range from 50 kc. to 50 mc., and is described by the manufacturers as a high speed laboratory and factory instrument for the measurement of coils, condensers, resistors and other circuit components.



The direct reading calibration of the meter is correct within 1 per cent. The accuracy of measurement for all ordinary components is accurate to 5 per cent at any frequency up to 15 mc.

Two scale ranges are provided, from 0 to 250 and 0 to 500. The instrument operates from 110 volts, a.c., 60 cycle power, with a current consumption of approximately 50 watts. Three tubes are used: one type 45, one type 2A6 (which must be specially tested) and one type 80. It weighs 25 lb.

The operation of the circuit depends upon the connection of the components to be tested in a resonant circuit at the frequency of the impressed voltage. The ratio of the voltage across the reactance to the impressed voltage is the Q of the circuit, which can be read directly on the voltmeter incorporated in the instrument. The only operation necessary to make the measurement is bringing the component into resonance at the proper frequency. The list price of the device is $450.—*Electronics.*

✦

Transmission monitor

A MODULATION monitor combined with a distortion and noise meter for use in modulating the output of broadcast transmitting stations is offered by the General Radio Company, 30 State Street, Cambridge, Massachusetts. The device which is mounted for relay-rack use, is completely self-contained, operates from 60 cycle power, and requires only a simple radio frequency pick-up from the transmission to be measured. It is suitable for use on any transmitter from 50 to 500,000 watts output.

Over-modulation is indicated by a flashing light which flashes whenever the modulation exceeds a predetermined value that can be set on the meter. This flashing is entirely independent of line voltage and requires no initial adjustment. Distortion values of 1, 3, 10 and 30 per cent can be read, while noise and hum level ranges of 30, 40, 50 and 60 db. are provided. A 400-cycle audio frequency oscillator is used for distortion and noise measurements; this oscillator mounts on the same panel rack. Carrier shift, unsymmetrical modulation, can be read directly and continuously in per cent of the normal carrier on the carrier meter. Modulation percentage is indicated on a separate meter, which can be depended upon for 2 per cent accuracy from 30 to 10,000 cycles per second with a maximum of 4 per cent error at 50 per cent modulation level. Five tubes are required for operation. The list price is $462 for the complete transmission monitor assembly.—*Electronics.*

✦

Stable vibrators

A NEW LINE of vibrators with several desirable features and advancements in design, is announced by Oak Mfg. Co., 711 W. Lake St., Chicago, Illinois. The outstanding differences in construction are found in the separate set of driving contacts and in the driving coil, which incorporates a shorted winding for prevention of arcing across the driving contacts. The consequent elimination of wear and oxidation of the driving contacts assure starting under all operating conditions.

Longer use of the power contacts, because of the removal of the driving function from them, greatly increases the useful life of the unit.

The vibrator is available in both synchronous and non-synchronous types, both being only 3⅛ in. high by 1¼ in. in diameter. Standard 4 prong base mounting is used on the non-synchronous and standard 6 prong base mounting on the synchronous type.

Stability of output is assured as is evidenced by test runs in excess of 1,000 hours at 33 per cent overload.—*Electronics.*

Junior velocity microphone

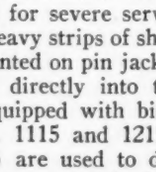
ABOUT THE size of a match box, with an output equal to a large velocity microphone, and an output that is constant with any position of the head, the new 7-point junior by the Amperite Corporation, 561 Broadway, New York City, hangs like a monocle from the speaker, so that it is always at the right distance from the microphone. The enthusiastic sports broadcaster can jump around, turn his head in any direction—but his audience will always be right with him. Walking after-dinner speakers will find it impossible to get away from this microphone.

Including the transformer, which is concealed inside the microphone case, the total weight is only 8 oz. It can therefore be used for a hand microphone as well. Obtainable with 50 or 200 ohm output impedance, it has a frequency response from 60 to 7,500 cycles and an output of —68 db. on open line. The microphone cable can be any length up to 2,000 feet. Its directional quality makes it easy to eliminate acoustic feedback and audience noises. —*Electronics.*

✦

Shunts for auto radio servicing

RECENTLY, the Triplett Electrical Instrument Company, of Bluffton, Ohio, announced its radio shunt. Triplett shunts are designed for severe service and are made from heavy strips of shunt material that are mounted on pin jack tips, which are plugged directly into tester jacks. They are equipped with binding posts. Shunts Nos. 1115 and 1215 (capacity, 15 amperes) are used to detect power pack and vibrator troubles in automobile radio sets. Shunts Nos. 1116 and 1218



(capacity, 30 amperes) are used to set the generator at the correct value in order to prevent the battery running down and the generator burning out when installing auto radios.—*Electronics.*

Noise-effect records

THE HOLLYWOOD transcription producer, Freeman Lang, 1357 N. Gordon Street, Hollywood, California, announces the formation of a sound-effects library on wax. The electrical transcriptions will be available to radio drama producers, station staffs and transcription producers, with every conceivable noise ranging from screams, doors slamming, monkeys chattering, jungle noises, etc.

The newest addition to the sound effects library was made when the noise reduction unit went to Los Angeles harbor to record the noises of a clam dredger, pulleys squeaking, the creak of booms, steam exhaust, splash of buckets and the drip of water.

The noise was recorded on film, cut to suitable length, built into the transcription program, and then also dubbed into electrical transcriptions for the sound effects collection.—*Electronics.*

✦

Carbon suppressor brush

A RECENT automotive radio development now being manufactured by The Ohio Carbon Company, 12,508 Berea Road, Lakewood, Ohio, is a carbon brush containing high-resistance material and designed for use on radio-equipped Ford V-8 cars.

It is customary when installing radio sets on cars to introduce resistance between the distributor and the coil. This was not previously possible in the case of the Ford V-8 car because of the combined distributor-coil unit. The new brush, however, fulfills the same function. In developing this brush the manufacturers state that its long-wearing and other qualities have been in no way sacrificed.—*Electronics.*

✦

Portable cathode-ray oscillograph

A COMPLETE portable a-c operated cathode ray oscillograph is announced by the RCA Parts Division, RCA Manufacturing Co., Inc., Camden, N. J. The oscillograph lists for $84.50 complete with tubes, including an RCA-906 cathode ray tube, and is known as Type TMV-122-B. Two separate power supplies, one for the cathode ray tube and one for the amplifier, are included, together with a saw-tooth frequency generator for sweep circuit use. The sensitivity is 2 volts d-c per inch for both vertical and horizontal deflection, flat within 10 per cent between 20 and 90,000 cycles per second. The sweep circuit has a frequency range from 20 to 15,000 cycles per second, permitting six cycles to be viewed when 90,000 cycles per second is on the oscillograph.—*Electronics.*

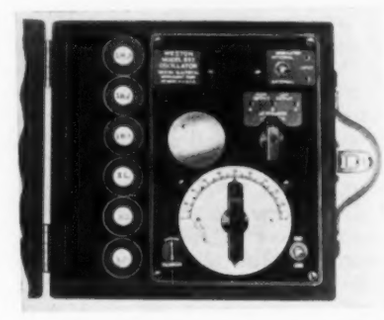
Rectox meters in 200 micro-ampere range

A PRINTER'S error in the February issue is responsible for the announcement that the Westinghouse Electric & Manufacturing Company of Pittsburgh, have Rectox heaters available in 20 micro-amperes size. The smallest range manufactured in this line is 200 micro-amperes.

✦

Test oscillator

A NEW TEST oscillator designed to meet the servicing requirements of all-wave radio receivers has been announced by the Weston Electrical Instrument Corp., Newark, New Jersey. The frequency range is from 100 kc. to 22 megacycles. A special attenuator system makes possible an approximate output of one microvolt. Plug-in coils are used to eliminate switching leads, thus reducing



electro-magnetic and electro-static fields within the oscillator. The output range of the oscillator varies from .2 volts to 1 microvolt with a constant impedance of 200 ohms at the output jacks throughout this range. The oscillator, known as type 692, is battery-operated and is equipped with two type 30 tubes. Complete with coil battery and carrying case, the unit weighs approximately 12 lb.—*Electronics.*

✦

Impedance-matching networks

PI-SECTION impedance-matching networks for use in matching the output of a transmitter to the transmission line or radiating system are offered by the E. F. Johnson Co., Waseca, Minnesota. The network may be used either in the balanced or unbalanced form depending upon the nature of the load or the type of transmission line used. The size of the component parts used in the network depends upon the frequency range over which they are to be operated. The components may be obtained separately or as a unit, and should be ordered only with complete specifications for intended use. —*Electronics.*

32-Volt converter power supply

A NEW DUAL-ACTION vibrator converter for use on 32 volts in rural districts is announced by the Electronic Laboratories, Inc., 122 West New York Street, Indianapolis, Ind. The converter, which is completely self-contained, is designed to convert 32 volts d.c. into 110 volts a.c. with an output power of 100 watts. The input current is 4 amp. for a full load, the efficiency 72 per cent, and the regulation 80 per cent. The converter is housed in a lacquered metal case measuring $4\frac{5}{8}$x$6\frac{3}{8}$ x10 in. and weighs approximately 12 lb. The vibrator, which is of new design, contains four semi-stationary reeds and one vibrating reed. According to the manufacturer, the contact points of the vibrator have a contacting area of four times that of any other type of vibrator. The power factor of the device has been slightly over-corrected by the introduction of the high capacity in the primary circuit. The list price is $25. —*Electronics.*

✦

Copy holder for microphone stand

MICROPHONE stands sold by the Universal Microphone Co., Inglewood, California, are now provided with a light weight copy holder for holding announcers' notes, music and lecture memos. The frame of the holder is made of frosted cadmium and will hold letterheads or smaller size sheets. The holder operates on a flexible arm and is easily adjusted or can be removed at will.—*Electronics.*

✦

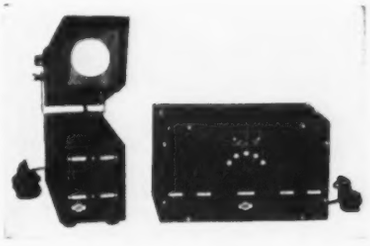
Broadcast transmitter

A BROADCAST transmitter of maximum power output of 250 watts, known as the 250-B radio broadcast transmitter, is being manufactured by Doolittle & Falknor, Inc., 1306 West Seventy-fourth Street, Chicago, Ill. The transmitter is operated entirely from 115 volts, 60 cycle, a.c. single phase power supply, and the overall efficiency at 100% modulation is approximately 16%. Two temperature control crystals are provided for frequency stability and the audio frequency response characteristics at 100% modulation varies less than 2 db. throughout the range from 50 to 8,000 cycles. The transmitter may be operated at 100 watts by means of a power-change switch which corrects the speech input level at the same time it changes the power output. The transmitter is mounted in two special racks for sub-panel mounting and all tubes are mounted on the panel front. The transmitter is of the Class-B, shunt feed, high level type.—*Electronics.*

Cathode ray equipment

CATHODE RAY oscillograph and oscillogram equipment for all laboratory, production, radio servicing, broadcast, and amateur applications has just been announced by The Clough-Brengle Co., of 1134 W. Austin Ave., Chicago, Illinois.

The model UF cathode ray oscilloscope employs the standard three-inch cathode ray tube, and provides all necessary power from a self-contained rectifier and filter system. A built-in 60-cycle sweep allows study of Lissajou's figures for analyzing voltages and currents.



Extremely high sensitivity of .31 millimeters deflection per volt has been secured. Thus full deflection is attained on either horizontal or vertical plates with only 90 volts. Intensity is sufficient for easy observation in daylight. Photographs can be made with any ordinary bellows camera. A device is incorporated which allows tracing curves on ordinary vellum paper and eliminates much need for photography.

Coils for magnetic deflection are available for applications requiring this operation. A linear sweep unit for visual plotting of i.f. response curves and other receiver alignment adjustments is available for production and field service applications. Complete descriptive bulletins are available on request.—*Electronics.*

✦

Multiple household antenna

A MULTIPLE antenna for use in households having more than one radio has been announced by the Technical Appliance Corp., 27-26 Jackson Ave., Long Island City, N. Y. A single aerial wire installed as high as possible for maximum signal-to-noise ratio is used, but individual coupling units are connected at points along the lead-in, one for each radio. The system is licensed under A. A. K. patents. The coupling unit mounts inside the window casing, and measures 1½ by 2 by ½ inches in a cadmium plated case. The system is supplied in kit form, ready for installation either by the set-owner or his serviceman.—*Electronics.*

Thermal timing relay

THE EDISON Electrical Controls Division of Thomas A. Edison, Inc., Orange, New Jersey, has designed a new timing relay to meet the demand for an accurate, long-life timer which will operate under extreme conditions. It is composed of an Edison type R-4 thermal relay which operates a magnetic contactor. The thermal relay may be calibrated to operate with a delay of a few seconds or several minutes. This unique device is the nerve center of the assembly. It is completely sealed in a glass tube from which all air has been exhausted. There is no destructive arcing and neither oil nor dirt can foul the contacts. There are no working parts to require cleaning, oiling, adjustment or replacement due to wear. The thermal relay is a permanent automatic timer on which time, use and disuse have no effect.

The magnetic contactor is provided with a spare set of contacts so that the unit may be used for sequence closing of two or more circuits. The timing relay is available for use on d-c as well as a-c.—*Electronics.*

✦

Semi-automatic transmitter tuning relay system

IN CHANGING transmitter tuning from one wave length to another it is desirable and necessary to effect the change in the shortest possible time, especially in airway communications. It is also essential that the transmitter be returned to identically the same wave length each time the same information is again being broadcast. To accomplish semi-automatic tuning of the transmitter the following equipment is used:

A six position selector switch mounted on the control panel, provides for selection of any one of five circuits and an off position. Selection of any one circuit may be made from any previous position of the switch without closing any other circuit. A relay is used to connect the transmitter for the desired wave length. It consists of five independently operated relays mounted side by side, each one having three normally open poles. The contacts short circuit various sections of the tuning coils and are located as close to the coils as possible.

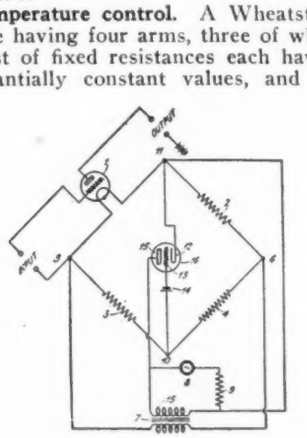
Struthers Dunn, Inc., of Philadelphia, Pennsylvania, specialists in relay manufacture, are in position to supply this equipment, and also the solution to most other problems involving relays. Similar equipment may also be had for transport companies, and other radio stations working on several wave lengths. Complete data will be sent on request to the above company.—*Electronics.*

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Electron tube applications

Electrical musical instrument. Use of a glow tube, a condenser and keys controlling several resistances located in the circuit to control the frequency. Nicholas Langer, Budapest. No. 1,993,890.

Temperature control. A Wheatstone bridge having four arms, three of which consist of fixed resistances each having substantially constant values, and the



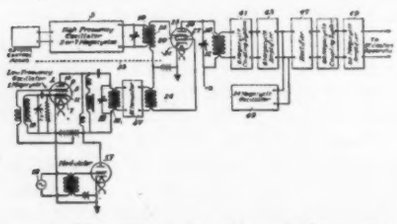
fourth arm containing the impedance of a device, the temperature of which is to be controlled. W. E. Kühle and Dietrich Prinz, Telefunken Co. No. 1,994,076.

Frequency control. In a system for maintaining a wave constant as to frequency and phase, by applying correcting voltages through a motor which through a worm and gear automatically adjusts the phase. R. E. Mathes, RCA. No. 1,992,625.

Production control. A light sensitive system comprising light on one side of a stream of products coming from the delivery, and a photo-cell on the opposite side. O. C. Roesen, Wood Newspaper Machinery Corp. No. 1,992,840.

Mobile transmitter. On a vehicle an odometer is responsive to the distance travelled by the vehicle. A radio transmitter is carried by the vehicle which automatically and repeatedly transmits a message in accordance with the readings of the odometer. J. A. Wells, Montclair, N. J. No. 1,993,497.

Signal generator. A source of modulated low frequency oscillations including a two-grid amplifier tube in which oscillations are produced between the



two grids, the tube then being plate modulated. G. L. Beers, R.C.A. No. 1,993,395.

Photo-electric relay. Controlling a grid controlled rectifier by a photo-electric device. W. D. Cockrell, G. E. Co. No. 1,992,055.

Regulator system. An arc discharge device controlled by an external grid connecting a translating device to a source of alternating current and means for regulation. P. H. Craig, Invex Corp. No. 1,992,146.

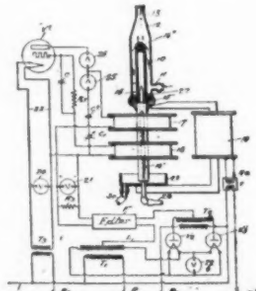
Paper inspection. Determining variations in the formation of a paper sheet by rotating the paper between a source of light and a photo-electric cell to integrate the variations in the current caused by variations in the formation of the paper. M. N. Davis, Paper Patents Co. No. 1,991,599.

Power factor control. A device for controlling the power factor of a circuit by means of a gas tube having a control grid. D. C. Espley, G. E. Co. No. 1,993,924.

Wave analyzer. A device for analyzing vibration by means of a frequency selector system, heterodyne circuit, etc. O. H. Schuck, Jr., Philadelphia, Pa. No. 1,994,232.

Synchronizing system. Maintaining the speed of a rotary element at a desired value by generating an alternating current having a frequency proportional to the speed of rotation and comparing the phase between this current and an independently generated current. E. S. Purington, John Hays Hammond, Jr. No. 1,994,230.

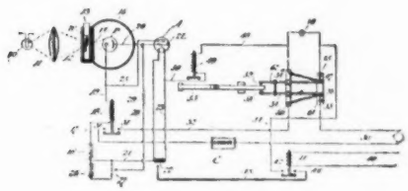
Method of dispersion. Preparing dispersions of two or more substances by passing the substances through a restricted area and subjecting them to high frequency vibrations within the



audio range and in particular apparatus comprising a source of compressional wave energy of approximately 8,000 cycles per second or less. L. A. Chambers and Newton Gaines, assigned to W. H. Ashton, Philadelphia, Pa. No. 1,992,938.

Modulated oscillator. The grid of a five-element tube is connected to a photocell receiving variable frequency light pulses. The screen and plate of this tube are connected to opposite ends of an inductance as in a push-pull amplifier, positive potential being applied to the plate through a shunt system. The center tap of the output inductance across which the plate and screen are connected is connected to ground through a condenser. J. N. Whitaker, R.C.A. No. 1,991,970.

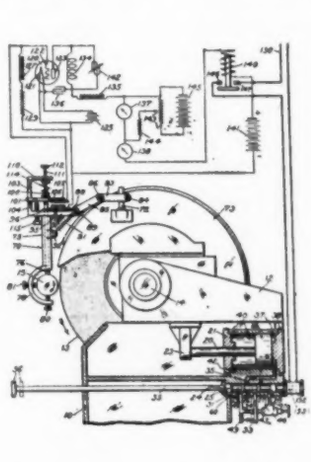
Watch timing. Apparatus for counting the operations of a watch and like movements, having an escape wheel



with a periodically moving part by means of a photo-sensitive cell, etc. F. D. Urie, Elgin National Watch Co. No. 1,991,477.

Electrical musical instrument. A light-sensitive means with provision for interrupting a light beam in accordance with a musical scale. R. H. Ranger, Newark, N. J. No. 1,991,522.

Electrical sizing device. In combination with a work sizing device, a piezo electric crystal and plate which are



movable relative to each other in response to minute variations in work size. C. J. Green, Norton Co., Worcester, Mass. No. 1,992,027.

Pocket-size transmitter. A tube, a key, a quartz crystal, battery, etc., "all said parts being arranged in a casing of pocket size." Heinrich Eberhard, Berlin. No. 1,993,436.

Sound recording system. Use of a recording galvanometer with a vibrating mirror and a resistance having a positive temperature coefficient responsive to the amplitude of the impulses modulated with the sound for maintaining the vibrations of the mirror within a predetermined range. E. J. Townsend, R.K.O. Corp. No. 1,997,024.

Recording on steel. A play-back method in which sound, ultimately to be recorded as a phonograph record on film or records, is first recorded magnetically upon a steel member at a predetermined rate of speed. The ultimate record can be made from this magnetic record, which may be played back at any time. T. H. Nakken, Nakken Patents Corp. No. 1,993,616.

Timing axis circuit. P. L. Hoover and E. D. Kennedy, assigned to Endowment Foundation, New Brunswick, N. J. No. 1,978,461.

Oscillograph circuit. Dietrich Prinz, Telefunken. No. 1,977,999.

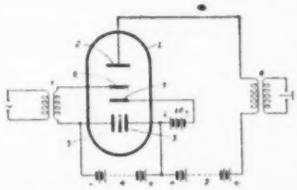
Electron tubes

Short wave tubes. The following patents have been granted on tubes for generating or use in high-frequency circuits: No. 1,995,848 and 1,997,053 to E. W. B. Gill, R.C.A., on tube construction; No. 1,991,282 to Karl Kohl, Germany, on Barkhausen-Kurz tubes; No. 1,987,989 to A. G. Clavier, W.E. Co., short-wave oscillation generator.

Crater lamp. A lamp having a cathode with a parabolically curved crater. C. P. Brockway, National Television Corp. No. 1,991,728.

Phototube construction. Method of oxidizing the surface of a silver electrode by exposing the electrode to oxygen at a pressure of 0.20 millimeters of mercury, measured at 20 deg. C., the ratio of the total volume of oxygen, measured in c.c., to the surface area of the electrode measured in sq.cm., being of the order of 1000/80, subjecting the electrode to the action of a glow discharge and maintaining the discharge until the pressure of the oxygen has fallen to substantially 0.14 millimeters of mercury. W. F. Tedham, E&MI, Ltd. No. 1,988,525.

Gaseous amplifiers. The following patents on ionic discharge tubes: No. 1,989,461 and No. 1,989,462 to Samuel Ruben, New Rochelle, N. Y., on an ionic discharge amplifier; No. 1,984,877



to G. Jobst, Telefunken, on an amplifier having a gaseous cathode; No. 1,986,397 to August Hund, Wired Radio, Inc., on a gaseous tube with a negative resistance characteristic.

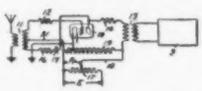
Tuning indicator tube. Patents No. 1,994,726 to R. T. Orth, R.C.A., and No. 1,994,733 to B. J. Thompson, on the use of fluorescent material in a tube to indicate progressively varying voltages as applied to the grid.

Cathode coating apparatus. Apparatus for coating electrical conductors of a filamentary material. Victor L. Ronci, B.T.L., Inc. No. 1,986,534 and No. 1,986,533.

Radio circuits

Antenna system. A multiplex receiving system. E. V. Amy and Frank King. No. 1,995,731.

Anti-static device. Method of restricting the energy of static disturbances to



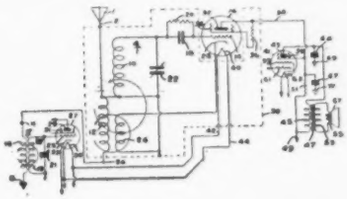
the signal energy level. H. L. Saxton, G.E. Co. No. 1,992,044.

Short wave circuit. Antenna and tube for ultra short wave operation. H. E. Hollman, A.T.& T. Co. No. 1,994,219.

Radiotuner. A mechanical pre-selector system. E. A. Zadig, R.C.A. No. 1,992,407.

Remote control. Remote control and time control radio receiving system. W. T. Powell, Stromberg-Carlson Telephone Mfg. Co. No. 1,992,326 and No. 1,992,327.

Short wave adapter. No. 1,996,847 to



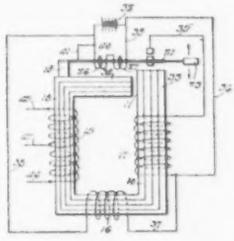
R. F. Zimmerman and H. W. De Weese, Dayton, Ohio.

Short wave transmitter. A metallic plate having a plane surface, an oscillator mounted thereon and in fixed relation thereto, a directional antenna mounted on said plate spaced one-quarter of a wave length from the plate. Maurice Ponte, Paris. No. 1,997,075.

Remote control. Controlling the operation of a radio receiver over house current power lines. A. S. Blatterman, Asbury Park, N. J. Sept. 2, 1930. No. 1,994,603.

Anti-static device. A static reducing system comprising a high potential energy capacity unit, including several plates with coils wound on the plates, the coils being connected in series. One side of the unit is connected to the usual antenna, and a pair of load coils interposed between the unit on its opposite side and ground. The two load coils are connected in series, and a magnet is connected in series between the load coils. W. W. Wallace, Frederick, Md. No. 1,994,628.

Converter. A device for providing a source of electrical energy of pulsating unidirectional potential from a source of alternating current, comprising an iron



core, a vibrator, etc. T. A. Cohen, Wheelco Vacuum Products Co., Chicago. No. 1,994,635.

Television

Cathode ray scanning systems. R. L. Campbell, R.C.A. No. 1,995,376.

Also, method of extinguishing the fluorescent effect in a cathode-ray tube by means of invisible light waves for scanning purposes. Fritz Schröter, Telefunken. No. 1,996,492.

Recording system. Using several microphones of different characteristics and a pair of light polarizing devices with a Kerr-cell between the devices and a record. V. K. Zworykin, WE&M Co., 1927. No. 1,996,449.

Scanning system. A lens scanning disc method. R. D. Kell, G. E. Co. No. 1,992,009.

Synchronizing system. A synchronizing dash is transmitted with each line of the picture together with the picture current. H. G. Möller, Fernseh Akt., Berlin. No. 1,993,564.

Tone control. The image to be televized is seen in several mirrors, each of which is used to control the production of light radiations of a distinct color. H. E. Ives, B.T.L. No. 1,993,604.

Modulating system. Sound modulations are impressed upon the output of a rectifier which feeds a generator producing invisible radiations. These modulations are used to record on film. B. B. Bryant, Brooklyn, N. Y. No. 1,997,356.

Patent suits

1,455,141, Lowell & Dunmore, Radio receiving apparatus; 1,606,212, same, Power amplifier; 1,635,117, F. W. Dunmore, Signal receiving system, appeal filed Dec. 15, 1934, C. C. A., 4th Cir., Doc. 3816, P. D. Lowell, et al. v. A. G. Triplett, et al.

1,251,377, 1,297,188, 1,573,374, 1,728,-879, filed Dec. 4, 1934, D. C., S. D. Calif. (Los Angeles), Doc. E 462-M Radio Corp. of America, et al v. H. C. Block (Custom Built Radio Mfg. Co.). Doc. E 467-M, Radio Corp. of America, et al. v. J. T. Kelly, Jr. (Kelly Music Co.). Patents held valid and infringed Dec. 17, 1934. Doc. E 463-H, Radio Corp. of America, et al. v. R. Rawlings (Rawlings Radio Co.). Decree as above.

1,879,863, H. A. Wheeler, Volume control, filed Dec. 20, 1934, D. C., N. D. Ill., E. Div., Doc. 14,247, Hazeltine Corp. v. Stewart-Warner Corp.

1,448,279, 1,579,392, Pridham & Jensen, Electrodynamic receiver; 1,745,118, same, Sound reproducing device, D. C., N. D. Calif. (San Francisco), Doc. E 3210-S. The Magnavox Co. v. Waterhouse-Lester-Scovel Co., Ltd. Dismissed without prejudice Dec. 4, 1934.

1,507,016, L. de Forest, Radio signaling system; 1,507,017, same, Wireless telegraph and telephone system, filed Dec. 21, 1934, D. C., S. D. N. Y., Doc. E 79/222, Radio Corp. of America et al. v. Oscar Radio Shop, Inc., et al. Doc. E 79/233, Radio Corp. of America et al. v. North Radio Co., Inc., et al. Doc. E 79/224, Radio Corp. of America et al. v. B. Shaw (Shaw Radio Co.). Doc. E 79/225, Radio Corp. of America et al. v. L. C. Badanes et al. (East Radio). Doc. E 79/226, Radio Corp. of America et al. v. Amco Stores, Inc., et al. Same, D. C. N. J., Doc. E 4981, Radio Corp of America et al. v. Hygrade Sylvania Corp. Decree for plaintiff Dec. 22, 1934. Same, filed Dec. 29, 1934, D. C., S. D. N. Y., Doc. E 79/233, Radio Corp. of America et al. v. Furst Radio Corp. et al. Doc. E 79/235, Radio Corp. of America et al. v. Post Radio, Inc., et al. Doc. E 79/235, Radio Corp. of America et al. v. H. & B. Radio Corp. et al.

1,251,377; 1,297,188; 1,573,374; 1,707,-617; 1,795,214; 1,894,197, filed Dec. 24, 1934, D. C., N. D. Ill., E. Div., Doc. 14,253, Radio Corp. of America et al. v. F. M. Lund et al. (Capitol Radio Co.). Doc. 14,259, Radio Corp. of America et al. v. International Trading Corp. et al.

1,251,377; 1,297,188; 1.573,374; 1,728,-879, filed Dec. 4, 1934, D. C. S. D. Calif. (Los Angeles), Doc. E 464-H, Radio Corp. of America et al. v. R. S. Shelley et al. (Peter Pan Radio Co.).

BRITISH PATENTS

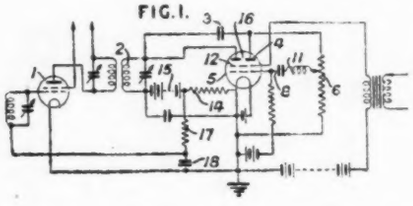
British patents are important to American readers because these disclosures often forecast corresponding U. S. patents which may not be issued until a year later.

Radio circuits

Automobile antenna. A highly-capacitative antenna with a relatively small pick-up is closely coupled to the input coil, and the resulting transfer of capacity and consequent restriction in wave-band is offset by using permeability tuning. E. K. Cole. No. 420,702.

Automatic volume control. A delayed system in which the action is produced by a biassing source connected between the rectifier load and the source of high

FIG. 1.

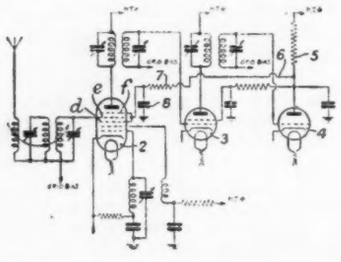


frequency potential to be rectified, the cathode of the rectifier being at ground potential. E. Y. Robinson, Associated Electrical Industries, Ltd. No. 420,789.

Anti-static device. A limiting tube is placed between the aerial and the input circuit of a radio receiver to reduce the amplitude of atmospheric and other disturbances. British Thomson-Houston Co. No. 420,886.

A-c d-c receiver. Push-pull amplifier tubes are biassed by connection to the center of two resistances across each of the cathodes of the push-pull tubes. R. P. Wuerfel. No. 420,889.

Automatic volume control. A-v-c voltages are applied to two electrodes, one on each side of the modulator grid



of a tube having at least seven electrodes and acting as a combined local oscillator and first detector in a superheterodyne. E. K. Cole. No. 421,075.

Hum elimination. Hum due to temperature variations of the cathode of a tube heated by a fluctuating current, is eliminated by a cold electrode, for example, the grid, connected to two or more points of the heating circuit by impedances of different character of such magnitude that the cold electrode receives a compensating a-c component displaced 90 deg. in phase relative to the heating current fluctuations and of a magnitude inversely proportional to the frequency of the heating. L. M. Ericsson. No. 421,186.

Television circuits

Call signals. A portion of a photo-sensitive mosaic screen on which an optical image of the view is projected is used for developing signals additional to the picture signals. The call letters of the transmitter may be transmitted continuously and independently of the view by placing in front of the photo-sensitive surface a mask shaped to the call letters. H. A. Iams, Marconi Co. No. 420,479.

Synchronizing system. Method by which differences in the amplitude of synchronizing signals are reduced and ground noises and similar disturbances below a certain maximum are eliminated. E&MI, Ltd. No. 419,441.

Mosaic screen. A mosaic consisting of short aluminum wires with a thin insulating coating of aluminum oxide covered by a conducting film of silver. The photo-electric emission from the screen is collected by a grounded grid. Each element of the mosaic thus receives a charge dependent on the strength of the incident light. When the cathode-ray is incident on an element, the latter

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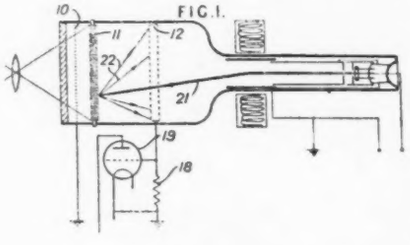
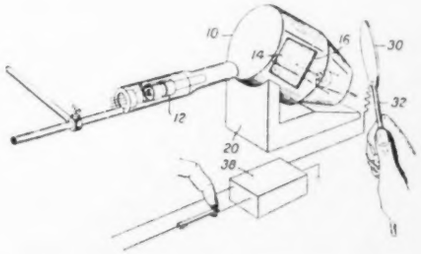


reaches the negative potential at which its retarding effect on the ray so reduces its speed that the number of secondary electrons equals the number of primary electrons. The number of secondary electrons emitted thus varies with the charge given photo-electrically to each element of the mosaic. E&MI, Ltd. No. 419,452.

Wide-band amplifier. A resistance capacity coupled amplifier in which the loss of amplification at high frequencies is counteracted by means of a back-coupling circuit which neutralizes the effect of the inherent capacity of the tube. This back-coupling is supplied through a condenser from the plate circuit to the input which comprises an inductance. British Thomson-Houston Co. No. 419,914.

Automatic brightness control. A correct mean brightness of a reproduced picture relative to the brightest and darkest tones is maintained automatically by regulating the grid bias of the tube feeding the light source. Fernseh Akt., Berlin. No. 420,727.

Mosaic screen. Construction method involving oxidizing uniformly and to a desired degree a screen by producing a high-frequency field exterior to and independent of the container and varying the intensity of the field with respect to different parts of the structure. The field may be produced by an electrode on an insulating handle and connected to a source of high-frequency, high-voltage oscillations. The container enclosing the mosaic screen of silver globules on a mica sheet is supported on an insulating block and is evacuated and filled with oxygen at 1,500 microns. The field



ionizes the oxygen and the electrode is moved about until even oxidation of the screen produces an even color thereon. The oxygen is finally evacuated and the screen is photo-sensitized with caesium. S. F. Essig, Marconi Co. No. 421,201.

Scanning system. In a cathode-ray set, the ray is extinguished during the return path to the beginning of successive pictures. M. von Ardenne. No. 417,590.

Frequency multiplier. The line scanning frequency utilized for controlling or driving the generating ray deflecting energy is derived from the picture scanning frequency by a multiplication process wherein the fundamental frequency is multiplied in a distorting device of such volt-ampere characteristic that the output wave has an average periodicity at the multiplied frequency. Various types of multipliers are described, among them differentially biassed push-pull or full-wave rectifiers, differentially biassed saturable inductances or vacuum rectifiers, a cathode ray multiplier in which the beam impinges on a target having alternate cut away portions, or a photocell method. Telefunken. No. 417,932.

Mirror screw system. Placing mirrors correctly by a telescopic method. Suddeutsche Telefon-Akt.-Ges. No. 418,566.

Scanning system. Combination of three or more mirror polyhedrons or lensed discs or drums. One polyhedron rotates at a speed which is an integral multiple of that of the others. J. L. Baird. No. 418,759.

Rotating mirror. A rotating mirror reflects the picture to, or receives it from, a fixed ring of inwardly-facing mirrors which comprise a spiral of plano-convex lenses silvered on the outer convex surface. I.M.K. Syndicate. No. 419,120.

Sweep circuit. In an electrical time-base circuit for cathode ray systems, in which a condenser is gradually charged and rapidly discharged, the discharge occurs over a thermionic tube, under the control of a second tube, the two tubes being reciprocally coupled by resistances connected between their anodes and the positive pole of the voltage source and by connections between the anode of each tube and the grid of the other, so that a rise of anode current in the discharging tube brings about a cumulative rise of potential on its grid, to hasten the discharge. A. C. Cossor, Ltd. No. 419,298.